BAAQMD
LIBRARY

CONTRA COSTA COUNTY
AIR TOXICS EXPOSURE STUDY

EPA SUPPLEMENTAL GRANT OBJECTIVES E-85/G-86

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
PLANNING DIVISION

PRINCIPAL CONTRIBUTORS:

B. BATEMAN
T. UMEDA

DECEMBER, 1988

POL
TOX
BAAQMD
LIBRARY

TABLE OF CONTENTS

I. INTRODUCTION

I.1 BACKGROUND

Over recent years, increased public attention has been focused on the health risks from toxic air contaminants (TACs). Particular concern has been expressed over exposure to TACs in highly populated urban areas that contain concentrated levels of industrial activity. Within the San Francisco Bay Area, perhaps the most significant combination of heavy industry and high population density exists in the northern portion of Contra Costa County. In particular, this area is a major center for petroleum refining and chemical production activities that coexist with a substantial and expanding residential population.

Considerable efforts have been initiated by federal, state, and local agencies to identify, evaluate, and control TACs. Air quality dispersion models have been previously used to estimate population exposure to TACs for regulatory planning purposes. The most comprehensive such study to date was completed by the Environmental Protection Agency (EPA), where the Human Exposure Model was used to characterize exposure to airborne carcinogens in the development of National Emission Standards for Hazardous Air Pollutants (EPA, 1985). The EPA study was national in scope and was used for prioritizing regulatory attention, but was not designed to provide detailed information regarding exposure to TACs for any specific urban area.

This report is a summary of a dispersion modeling study that was conducted by the Bay Area Air Quality Management District (BAAQMD) to provide detailed estimates of population exposure to specified TACs in Contra Costa County. There were two major components to the project: (1) compilation of a comprehensive, spatially resolved emissions inventory and, (2) dispersion modeling of ambient TAC concentrations and concentration-population integration for a number of meteorologically distinct subregions. The study was supported by a supplemental grant from the EPA (Program Objectives E-85/G-86).

I.2 STUDY OBJECTIVES

The Contra Costa County Air Toxics Exposure Study was designed to fulfill two primary objectives:

(1) To Help Site Additional Ambient TAC Monitors

The collection of reliable ambient data for various toxic substances is paramount to the understanding of any air toxics problem. The BAAQMD and the California Air Resources

Board (CARB) have been conducting long-term ambient air toxics monitoring programs in the Bay Area for several years. The BAAQMD plans to expand the air toxics ambient monitoring network in Contra Costa County. The results of this exposure study will be used to help select the most appropriate locations for new ambient monitoring stations.

(2) To Focus Subsequent Air Toxics Investigations

This initial exposure study will provide preliminary identification of air toxics source/receptor relationships in Contra Costa County. This information will be useful in directing efforts for refining air toxics inventories and exposure modeling results. These refined data bases can then be used to identify the sources that contribute most significantly to exposure to TACs. This information will be valuable in the development and implementation of air toxics control strategies.

TABLE II-1

AIR CONTAMINANTS CONSIDERED IN THE CONTRA COSTA COUNTY AIR TOXICS EXPOSURE STUDY

TAC NUMBER	TOXIC AIR CONTAMINANT
1	BENZENE
2	CARBON TETRACHLORIDE
3	CHLOROFORM
4	DICHLOROMETHANE (METHYLENE CHLORIDE)
5	1,4 - DIOXANE
6	ETHYLENE DIBROMIDE
7	ETHYLENE OXIDE
8	FORMALDEHYDE
9	PERCHLOROETHYLENE
10	PHENOL
11	TRICHLOROETHYLENE
12	VINYL CHLORIDE
13	ARSENIC (INORGANIC)
14	CADMIUM
15	CHROMIUM
16	POLYCYCLIC AROMATIC HYDROCARBONS

II. EMISSIONS DATA

A detailed spatially distributed emissions data base was compiled for modeling pollutant exposure. The inventory developed consists of point, area, and mobile source emission estimates for Contra Costa County and the adjacent BAAQMD portion of Solano County for the year 1987. The pollutant coverage consisted of sixteen toxic air contaminants (TACs) as specified by EPA Region IX. The pollutants were chosen on the basis of probable risk and availability of data. The TACs included in the inventory are listed in Table II-1.

The following sections contain: (1) general caveats regarding the inventory, (2) a summary of the inventory, (3) the methodology used in developing the inventory and, (4) the procedure for spatial allocation of emissions.

II.1 GENERAL CAVEATS REGARDING THE EMISSIONS INVENTORY

The emissions inventory used in this study was designed to include the best estimates of air toxics emissions from as many source types as possible, within existing resources. It should be emphasized that the potential exists for many sources of error in the development of an air toxics inventory, and that virtually every element of the inventory could be improved through further investigations. It is possible that "orders-of-magnitude" differences may exist between actual and calculated emissions for some sources.

Emission factors and species fractions used to develop inventory estimates may be generally applicable but may not accurately represent the source configuration, control equipment, and/or operating practices of a specific source or facility. The reader is therefore strongly cautioned against using the emission information contained in this document as an exact assessment of the emissions from any particular facility.

Certain sources of toxic pollutant emissions have not been included in the inventory due to a lack of acceptable data. This includes volatile organic compound (VOC) emissions from hazardous and municipal waste disposal sites, fugitive VOC emissions from refineries, emissions of metals from fugitive dust sources, and those hospital sterilizers and chrome platers that had not yet returned survey questionnaires.

II.2 SUMMARY OF THE EMISSIONS INVENTORY

A summary of the point, area, and mobile source emissions used in the exposure study is given in Tables II-2A and 2B. A more detailed breakdown of emissions by source category is given for each TAC in Appendix A for Contra Costa County.

TABLE II-2A

EMISSIONS INVENTORY OF 16 TOXIC AIR CONTAMINANTS IN CONTRA COSTA COUNTY FOR THE YEAR 1987

TAC	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Benzene	21.3	120.	358.	500.
Carbon Tetrachloride	75.2	0.	0.	75.2
Chloroform	3.05	4.11	0.	7.16
Dichloromethane	66.7	482.	0.	549.
1,4 - Dioxane	0.60	3.22	0.	3.82
Ethylene Dibromide	0.01	0.07	0.06	0.14
Ethylene Oxide	1.59	0.	0.	1.59
Formaldehyde	54.6	222.	163.	439.
Perchloroethylene	91.5	188.	0.	279.
Phenol	168.	97.9	0.	266.
Trichloroethylene	1.88	2.94	0.	4.82
Vinyl Chloride	0.	0.	0.	0.
Arsenic (Inorganic)	0.092	0.004	0.	0.096
Cadmium	0.035	0.083	0.137	0.255
Chromium	0.017	0.602	0.992	1.611
PAH's	0.12	7.27	5.08	12.5

Point source emissions are from facilities that exist in the permit data bank that have recorded UTM coordinates. The emissions from several facilities that are not in the permit data bank were also added to the point source inventory.

Area sources include emissions from all non-point sources except for on-road mobile sources. This includes sources that are too small and/or numerous to permit (e.g. domestic fireplaces), "non-traditional" sources (e.g. pesticide use), and sources that exist in the permit data bank but do not have recorded UTM coordinates (e.g. gas stations).

Mobile source emissions represent on-road vehicle emissions only. Emissions from off-road vehicles and aircraft were included as area sources.

TABLE II-2B

EMISSIONS INVENTORY OF 16 TOXIC AIR CONTAMINANTS IN THE BAAQMD PORTION OF SOLANO COUNTY FOR THE YEAR 1987

TAC	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Benzene	1.4	86.5	121.	**209.**
Carbon Tetrachloride	0.05	0.	0.	**0.05**
Chloroform	0.	1.19	0.	**1.19**
Dichloromethane	6.1	139.	0.	**145.**
1,4 - Dioxane	0.18	0.87	0.	**1.05**
Ethylene Dibromide	0.	0.04	0.02	**0.06**
Ethylene Oxide	0.21	0.	0.	**0.21**
Formaldehyde	5.9	99.7	69.5	**175.**
Perchloroethylene	5.4	34.7	0.	**40.1**
Phenol	0.	24.5	0.	**24.5**
Trichloroethylene	0.05	0.51	0.	**0.56**
Vinyl Chloride	0.	0.	0.	**0.**
Arsenic (Inorganic)	0.	0.001	0.	**0.001**
Cadmium	0.	0.084	0.064	**0.148**
Chromium	0.002	0.183	0.479	**0.664**
PAH's	0.	2.70	2.36	**5.06**

Point source emissions are from facilities that exist in the permit data bank that have recorded UTM coordinates. The emissions from several facilities that are not in the permit data bank were also added to the point source inventory.

Area sources include emissions from all non-point sources except for on-road mobile sources. This includes sources that are too small and/or numerous to permit (e.g. domestic fireplaces), "non-traditional" sources (e.g. pesticide use), and sources that exist in the permit data bank but do not have recorded UTM coordinates (e.g. gas stations).

Mobile source emissions represent on-road vehicle emissions only. Emissions from off-road vehicles and aircraft were included as area sources.

The emission rates of the sixteen TACs investigated range over several orders of magnitude. Of the pollutants included in the study, dichloromethane (methylene chloride), benzene, and formaldehyde have the highest annual emissions. Vinyl chloride, arsenic, and ethylene dibromide are the three TACs emitted in the lowest quantities.

Three of the sixteen pollutants covered in the inventory were emitted primarily from "industrial" point sources. Nearly all of the carbon tetrachloride emissions included in the inventory were from chemical manufacturing plants. Ethylene oxide emissions were associated with hospital sterilizers (the study area does not contain any commercial sterilizers, which are often large sources of ethylene oxide). The emissions of arsenic were primarily from stationary source combustion of sewage sludge and fuel oil.

Motor vehicles were the predominant sources of six of the pollutants included in the inventory. Motor vehicles were the primary sources of benzene emissions, with over half of the total emissions occurring from automobiles and light duty trucks. Motor vehicles were also the major sources of ethylene dibromide, which is used as an additive in leaded gasoline, although the overall emissions of this pollutant were quite low.

About half of the total formaldehyde and polycyclic aromatic hydrocarbon (PAH) emissions occurred from motor vehicles. The remainder of the emissions of these two TACs were primarily associated with wood combustion, largely from residential fireplaces. More than half of the total cadmium and chromium emissions were from motor vehicles, the largest contributor being diesel truck exhaust. Most of the remainder of the cadmium and chromium emissions occurred from stationary source fuel oil combustion. It should be noted that only a small fraction of the total chromium emissions from combustion sources is typically in the form of most concern as a TAC (i.e. hexavalent chromium).

Area sources contributed the majority of methylene chloride, chloroform, trichloroethylene, and 1,4-dioxane emissions. The predominant sources of methylene chloride were the use of consumer products and paint removers, with lesser amounts emitted from architectural coatings, chemical manufacturing plants, and degreasing operations. The major sources of chloroform emissions were related to the use of chlorinated drinking water, with the remainder of the emissions occurring from municipal wastewater treatment. The emissions of trichloroethylene were primarily from metal cleaning/degreasing operations, although the use of this solvent is quite low. The emissions of 1,4-dioxane were from trichloroethane (TCA) degreasing operations, and from the use of adhesives, surface coatings, and consumer products that contain TCA.

Perchloroethylene (PCE) and phenol had substantial area and point source components. The largest sources of PCE were dry cleaners, with a significant portion of the total emissions also attributable to chemical manufacturing plants and consumer product use. Nearly all of the phenol emissions included in the inventory were from wood combustion, with significant contributions from residential fireplaces and a large industrial waste-wood boiler.

Of the sixteen TACs selected for study, emissions for only one pollutant, vinyl chloride, could not be calculated. No known sources of vinyl chloride were identified in the study region, and other potential sources, including municipal and hazardous waste landfills, have not been adequately assessed and were therefore not included in the inventory.

II.3 METHODOLOGY USED IN DEVELOPING THE INVENTORY

This section contains a summary of the procedures used in compiling the emissions inventory used in the exposure study. A discussion of general inventory considerations is followed by more specific details regarding the methodology used in estimating point, area and mobile source emissions.

GENERAL INVENTORY CONSIDERATIONS

The air toxics inventory was based on the use of the following general guidelines:

(1) Actual Rather Than Allowable Emissions

An inventory may be based on allowable emissions, as reflected in each source's permit conditions or maximum activity levels. This study, however, was intended to produce realistic estimates of existing population exposure to TACs. The inventory was based on the best available estimates of actual emissions for the year 1987.

(2) Routine Rather Than Accidental Emissions

The inventory included only point source emissions that are considered to be "predictable" in nature, including those occurring from continuous and intermittent scheduled operations. Short term, unscheduled accidental emissions (e.g. releases due to control equipment failures) were not included in the inventory.

(3) Annual Rather Than Short Term Emissions.

Because cancer is the health effect of most interest, the study was designed to produce long term estimates of

exposure. The inventory was therefore based on annual emissions.

(4) Both "Process" and Fugitive Emissions.

For some TACs, fugitive emissions may be a very significant component of total emissions. Fugitive emissions are the unintended emissions due to minor leaks, spills, vapor losses, etc. associated with various steps of storing, moving, and processing materials. Examples are: leakage from valves, flanges, pump seals, etc. Though individual sources are usually small, total fugitive emission rates can be large. Process (i.e. stack) emissions have, however, traditionally been the focus of emissions inventories, so that data regarding fugitive air toxics emissions is limited. Where possible, both process and fugitive emission estimates were included in the inventory. One notable exception was the fugitive TAC emissions from refineries. These emission estimates (believed to consist primarily of benzene) are being compiled by the BAAQMD, but were not available to be included in this study.

POINT, AREA, AND MOBILE SOURCE INVENTORY METHODOLOGIES

The emissions inventory developed consists of three components: point, area, and mobile sources. Point sources consist of discrete stationary sources or facilities that, for the most part, exist in the BAAQMD permit data bank with recorded UTM coordinates. Area sources consist of all other sources (i.e. non-point sources), except for on-road mobile sources. This includes sources that are too small and/or numerous to permit, "non-traditional" sources (e.g. accidental fires), and sources that exist in the permit data bank without recorded UTM coordinates (e.g. gas stations). Mobile sources consist of on-road vehicles only. Emissions from off-road vehicles and aircraft were included as area sources. The distinction between point, area, and mobile sources determines the manner in which emissions are spatially allocated for modeling purposes.

The specific methodologies used in developing emission estimates for each TAC are discussed in two appendices to this document. Appendix B provides details regarding the point source inventory methodology. Appendix C contains the details of the area and mobile source inventory methodologies.

The three general methods used to develop the inventory emission estimates are:

(1) Emission Factors

Toxic air contaminant emission factors were applied to activity levels or throughputs to estimate emissions for

specific source types. Emission factors were taken from or were derived from a number of sources in the literature. Point source throughputs were based on the most recently reported information in the permit data bank. Mobile source activity information (e.g. vehicle miles travelled) was provided for each county by CARB. The emissions for some area source categories were based on "per capita" emission factors.

(2) Species Fractions

Species fractions are apportioning factors that are applied directly to VOC or particulate matter (PM) emission totals rather than to activity levels. Species fractions were taken from or were derived from information in the literature. VOC and PM emissions were taken from BAAQMD computer files for point sources and from BAAQMD 1987 inventory projections for area source categories. VOC and PM emission totals for mobile sources were provided by CARB.

(3) Material Balances

Material balance emission estimates are based on the emitted fraction of a material input to or used in a process. For most source types where material balances were used, it was conservatively assumed that 100% of the material used was emitted (e.g. ethylene oxide from hospital sterilizers).

II.4 PROCEDURE FOR SPATIAL ALLOCATION OF EMISSIONS

The dispersion modeling analysis was performed with a spatially resolved emissions data base with 1x1-kilometer grid cells. Maps showing the spatial pattern of emissions of each TAC are given in Section IV of this report. Areas are labeled in Universal Transverse Mercator (UTM) coordinates.

The methodologies for spatial allocation of emissions for point, area, and mobile sources are as follows:

POINT SOURCES

The point source inventory consisted of over 1300 individual emission sources. Where possible, individual sources were located at their UTM coordinates. Otherwise, they were located at the UTM coordinates of the plant centroid. The point source inventory was compressed for modeling purposes by locating groups of "minor" sources together at the centroid of each facility.

III. MODELING APPROACH

The dispersion model LONGZ (Bjorklund et al., 1982) was used to estimate pollutant concentrations in the study region. The LONGZ model, included in EPA's User's Network for Applied Modeling of Air Pollution (UNAMAP), uses the steady-state univariate Gaussian plume formulation. This model was selected because it can account for concentration variations due to plume rise and receptor elevation, and it can compute annual average concentrations given meteorological data in Statistical Array (STAR) format. The model can also accommodate a large number of source/receptor combinations.

The following sections contain: 1) a description of the meteorological and topographic input data used with the LONGZ model, 2) a discussion of the modeling methodology used and, 3) a summary of the procedure used to estimate population exposure.

III.1 METEOROLOGICAL AND TOPOGRAPHIC INPUT DATA

The study region consisted of the northern portion of Contra Costa County. Because of its terrain features, this area is meteorologically complex for Gaussian modeling. To produce more representative wind fields, the study region was divided into six meteorologically distinct subareas for modeling purposes. The wind data for each subarea consisted of local wind speed and direction data. The data were available from Ground Level Monitoring (GLM) stations located at industrial sites within the subareas.

The Concord area did not have appropriate local wind data, so data from the two nearest GLM sites were used in computing concentrations in the Concord subarea, and the higher of the two calculated impacts was reported. The GLM facility sites and the subarea(s) to which the meteorological data were applied are listed below. A map showing the six subareas used in the exposure study is given on the following page.

SOURCES OF METEOROLOGICAL DATA FOR SUBAREA MODELING

GLM Site	Name of Applicable Subarea
Tosco	Port Chicago and Concord
Chevron	Richmond
Union	Pinole
Shell	Martinez and Concord
Louisiana Pacific	Pittsburg

AREA SOURCES

The spatial distribution of area source emissions depended on source category. County emission totals for area source categories other than ships and aircraft were disaggregated using population and employment distribution data provided by the Association of Bay Area Governments (ABAG). The ABAG data consist of residential population, number of households, and six categories of employment, by 1-kilometer grid cell. A list of disaggregation factors used for each source category is included in Appendix D.

Ship and aircraft emissions were spatially distributed using separate procedures. Emissions from ships were distributed in 1-kilometer grid cells according to a "shipping-route" file compiled by the BAAQMD. Aircraft emissions were uniformly distributed in grid cells over and surrounding the largest airports.

MOBILE SOURCES

On-road mobile source emissions were distributed using a file containing motor vehicle total hydrocarbon and PM emissions by 1-kilometer grid cell. This file consists of link (i.e. hot stabilized) and trip-end emissions generated with the use of a transportation model. Gaseous organic TACs from mobile sources (i.e. benzene, ethylene dibromide and formaldehyde) were disaggregated in proportion to motor vehicle total hydrocarbon emissions. Mobile source TACs emitted as particulate matter (i.e. cadmium, chromium and PAHs) were disaggregated in proportion to motor vehicle PM emissions.

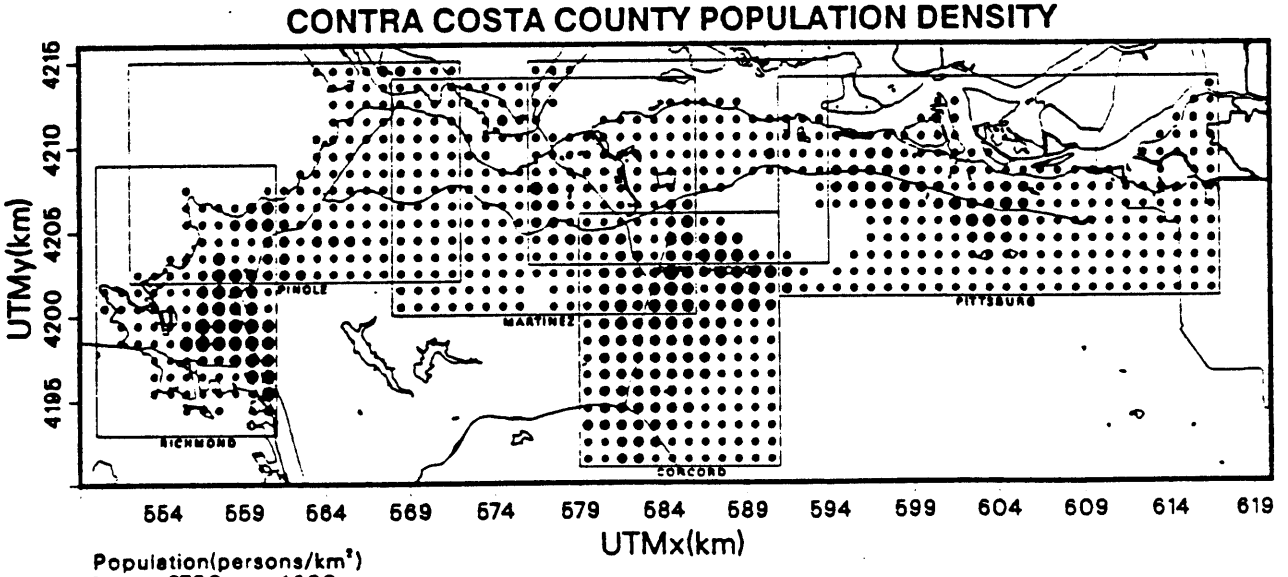
with 1/2-kilometer receptor spacings in the north-south and east-west directions. For the final analysis, the concentration field was averaged to 1-kilometer UTM grid cells to match the population data.

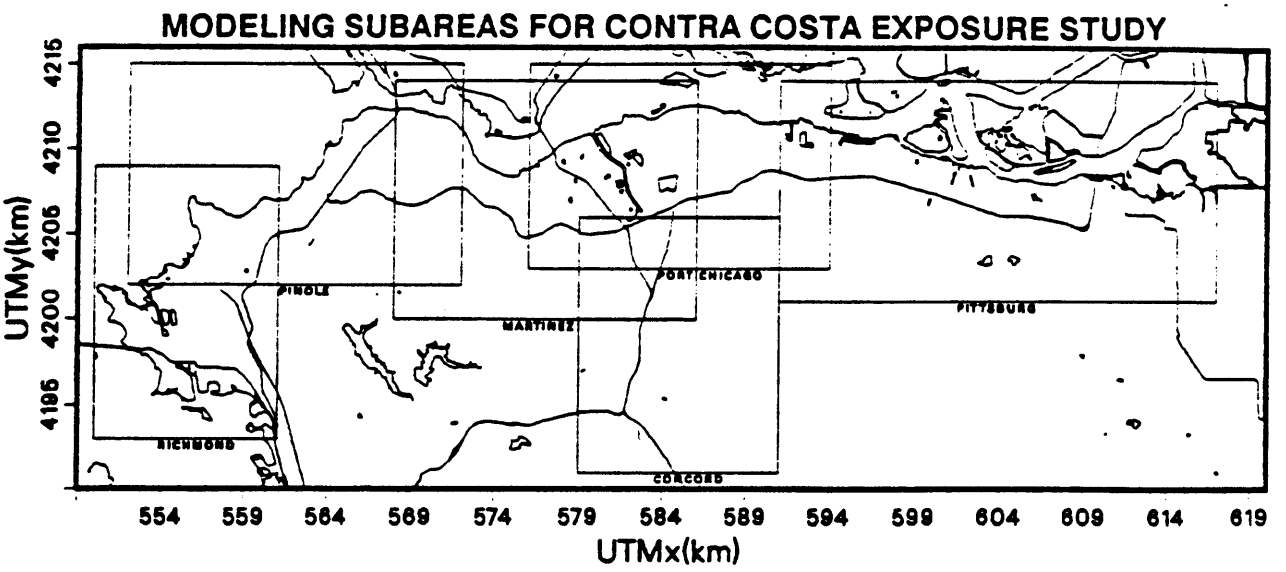
Unit source strength concentration fields were computed for each subarea using the appropriate STAR meteorological files. For subareas other than Concord and Richmond, this consisted of six different concentration fields corresponding to each of the six years of annual meteorological data from the applicable GLM site. For the Concord subarea, modeling was performed with meteorological data from two GLM sites, so that twelve different concentration fields were computed. For the Richmond subarea, only three different concentration fields were produced based on the three years of data available for this subarea. The maximum concentrations for all applicable meteorological data were determined for each source/receptor unit source strength. These maximum concentrations were used in the final analysis.

The Gaussian modeling completed was based on the simplifying assumption that the TACs emitted behaved as inert gases. No pollutant removal due to chemical transformations or deposition was assumed to occur.

III.3 POPULATION EXPOSURE ANALYSIS

Population exposure was computed for each 1-kilometer square grid cell as the product of annual average concentration and residential population density. Population estimates for 1-kilometer UTM grid cells were extracted from a data set obtained from ABAG. This population file was constructed assuming uniform population density for all grid cells within a given census tract. A map showing the population data used in the exposure study is given below.





The GLM data consisted of hourly wind speed and wind direction recorded over a period of six consecutive years from 1978 to 1983. Hourly stability classifications, for all subareas other than Richmond, were determined by combining local wind speed data with cloud cover observations taken at Travis Air Force Base during this six year period. Stability classifications for the Richmond subarea were based on Oakland Airport cloud cover data, which were available only for the three year period 1981 to 1983. Only three years of data were therefore used in modeling the Richmond subarea.

STAR meteorological data files for each year of data were produced by the STAR programs obtained from the National Weather Service. Statistical information on inversion base heights were unavailable, so these parameters were set to reasonable values based on BAAQMD meteorologists' experience.

Topographic data required by the LONGZ model to determine receptor elevations were extracted from files compiled by Lawrence Livermore National Laboratory from U.S. Geological Survey (USGS) digital map data. These files contain receptor elevations at a one-half kilometer horizontal resolution.

III.2 DISPERSION MODELING METHODOLOGY

Modeling of pollutant concentrations was similar to that performed for the Santa Clara Integrated Environmental Management Program (EPA, 1986), where unit source strengths for all source/receptor pairs were computed. Emission sources were modeled as either point or area sources. Area sources were distributed over 1-kilometer square grid cells. Point sources were simulated with relevant stack parameters so that the model could incorporate plume rise.

Receptor sites were based on a rectangular coordinate system

IV. RESULTS

IV.1 GENERAL CAVEATS

This study was designed to provide preliminary estimates of outdoor air toxics exposure in Contra Costa County in order to (1) help select sites for additional air toxics monitoring stations, and (2) provide a basis for subsequent, more refined, investigations. Unfortunately, the concentrations predicted in the modeling analysis cannot be validated in any rigorous manner at this time. Because of this, and because of potentially large sources of error in the emissions inventory and meteorology, and the simplified modeling approach used, the uncertainty in the results is unavoidably high. Therefore, the results cannot be used to estimate the actual public health impacts associated with exposure to TACs. The study does not include any health effects assessment.

A discussion of some of the ways in which the analysis could be improved in the future to reduce the uncertainty is included in Section V.

IV.2 SUMMARY OF RESULTS

The results of the Contra Costa Air Toxics Exposure Study are presented in a series of maps on the following pages. The maps depict the spatial patterns of emissions, ambient concentrations, and population exposures for the sixteen TACs investigated. Larger black dots on the maps represent larger quantities. Each set of maps is preceded by a summary of the emissions inventory for the applicable pollutant.

Results are indicated on the maps for each 1-kilometer UTM grid cell located within the study region subareas. Annual emissions are given in units of tons per year. Annual average ground-level concentrations are expressed in units of micrograms per cubic meter of ambient air (ug/m3). Population exposures are given in units of person-ug/m3. Note that the range of results for emissions, concentrations, and population exposures depicted in the maps is different for each toxic air contaminant.

The study region average concentration for a given TAC is given below the appropriate concentration map. This value is the mean annual average concentration for all grid cells included in the modeling subareas.

The aggregate exposure for a given pollutant is listed below the appropriate exposure map. Aggregate exposure is a measure of total population exposure within the entire study region, and is calculated by adding the exposures for all grid cells throughout the six subareas.

EMISSIONS INVENTORY SUMMARY
BENZENE

COUNTY	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Contra Costa	21.3	120.4	358.1	499.8
Solano	1.4	86.5	121.2	209.1

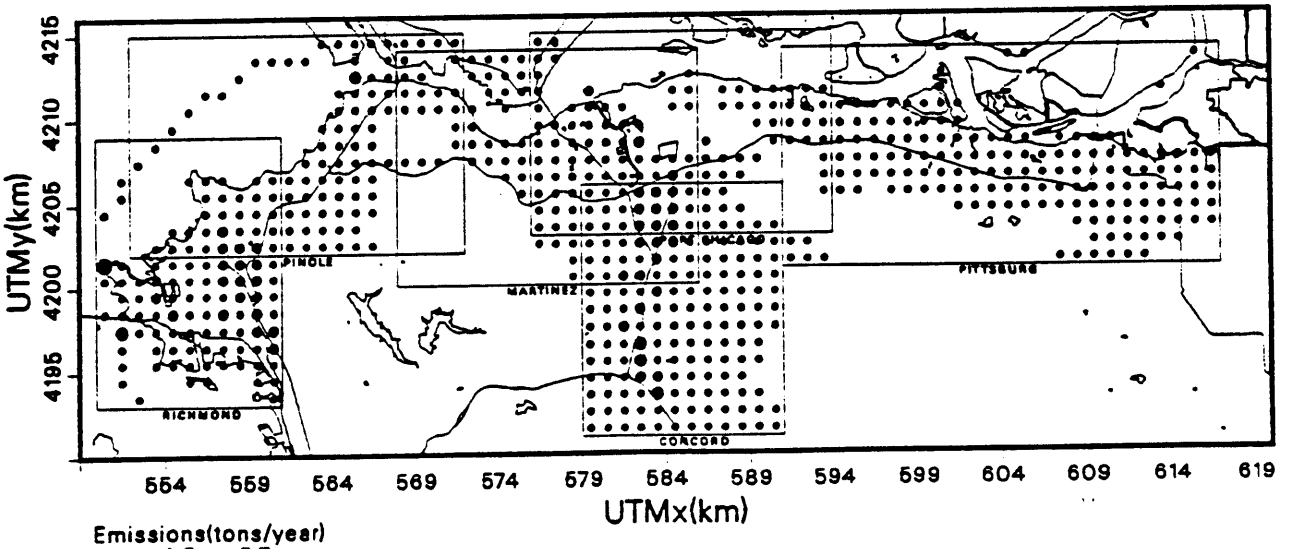
TOTAL EMISSIONS BY GENERAL SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (TPY)

CATEGORY DESCRIPTION	TPY BNZN	PERCENT OF TOTAL
ON-ROAD MOBILE SOURCES	358.1	71.65
OFF-ROAD MOBILE SOURCES	64.4	12.88
MISCELLANEOUS EMISSION SOURCES	24.6	4.91
STATIONARY FUEL COMBUSTION	24.2	4.85
PETROLEUM REFINERY EVAPORATION	10.6	2.12
OTHER ORGANIC COMPOUNDS EVAPORATION	7.2	1.44
FUELS DISTRIBUTION	6.5	1.29
AIRCRAFT	2.4	.49
OTHER INDUSTRIAL/COMMERCIAL	1.6	.31
BURNING OF WASTE MATERIAL	.3	.06

POINT SOURCE INVENTORY FACILITY LISTING (TOP 10)

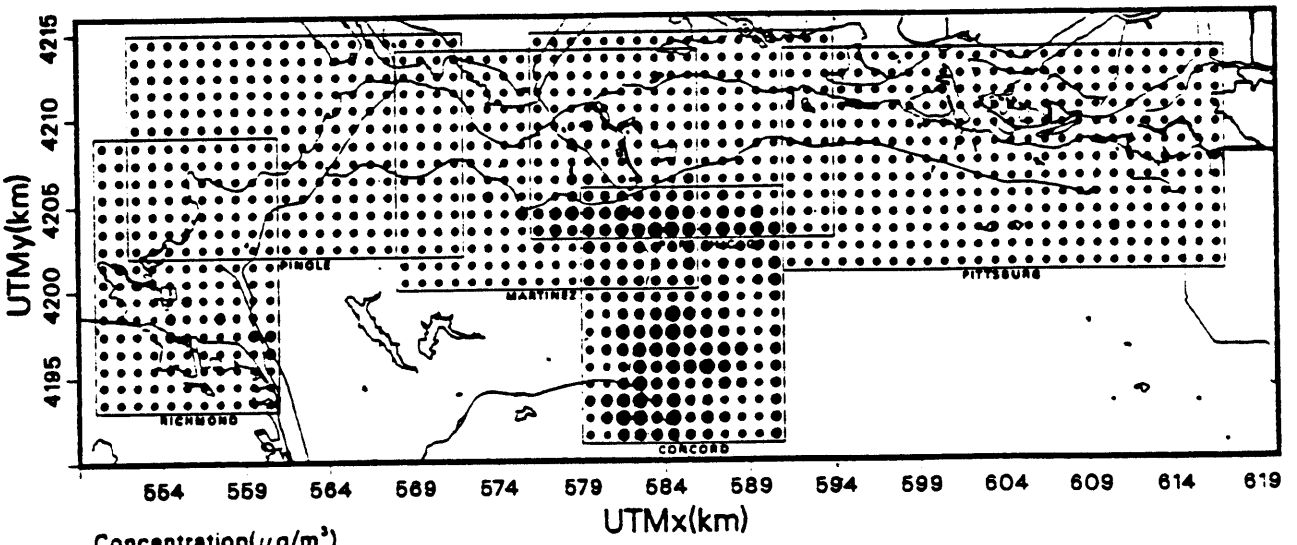
P#	PLANT NAME	CITY	TPY BNZN
125	Paktank Corporation - Richmond Terminal	Richmond	5.6
10	Chevron USA, Inc	Richmond	3.9
13	Tosco Corp, Avon Refinery	Martinez	3.3
16	Union Oil Company	Rodeo	2.8
72	Chevron U S A Inc	Richmond	1.1
15	Exxon Corporation	Benicia	1.1
32	Pacific Refining Company	Hercules	1.0
3158	Martinez Terminals Limited	Martinez	.5
57	Atlantic Richfield Company	Richmond	.5
581	Wickland Oil Terminal	Crockett	.4

CONTRA COSTA COUNTY
EMISSIONS OF BENZENE



Emissions(tons/year)
- ● = 4.5 - 5.7
- ● = 3.4 - 4.5
- ● = 2.3 - 3.4
- • = 1.1 - 2.3
- • = 0.0057 - 1.1

CONTRA COSTA COUNTY
CONCENTRATION OF BENZENE

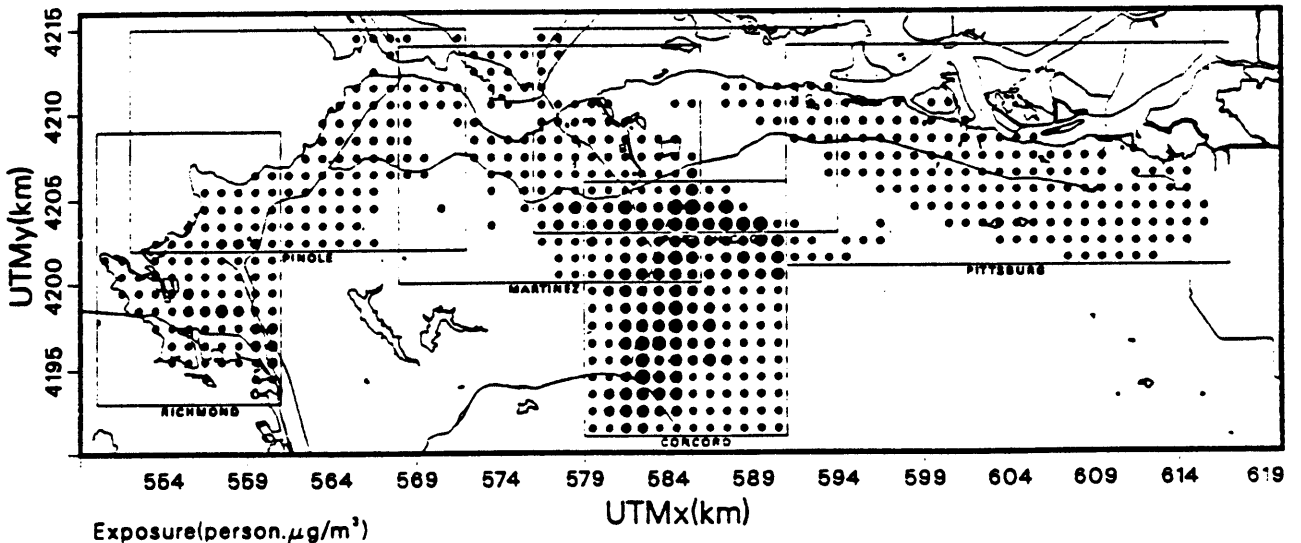


Concentration($\mu g/m^3$)

● =	9.3 - 12.
● =	6.9 - 9.3
● =	4.6 - 6.9
● =	2.3 - 4.6
• =	0.012 - 2.3

Study Region Average Concentration = 1.19 ug/m3

CONTRA COSTA COUNTY
EXPOSURE TO BENZENE



Exposure(person.$\mu g/m^3$)

● =	16000. - 20000.
● =	12000. - 16000.
● =	7800. - 12000.
• =	3900. - 7800.
• =	20. - 3900.

Aggregate Exposure = 1,239,501 person-ug/m3

EMISSIONS INVENTORY SUMMARY
CARBON TETRACHLORIDE

COUNTY	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Contra Costa	75.2	0.	0.	75.2
Solano	0.1	0.	0.	0.1

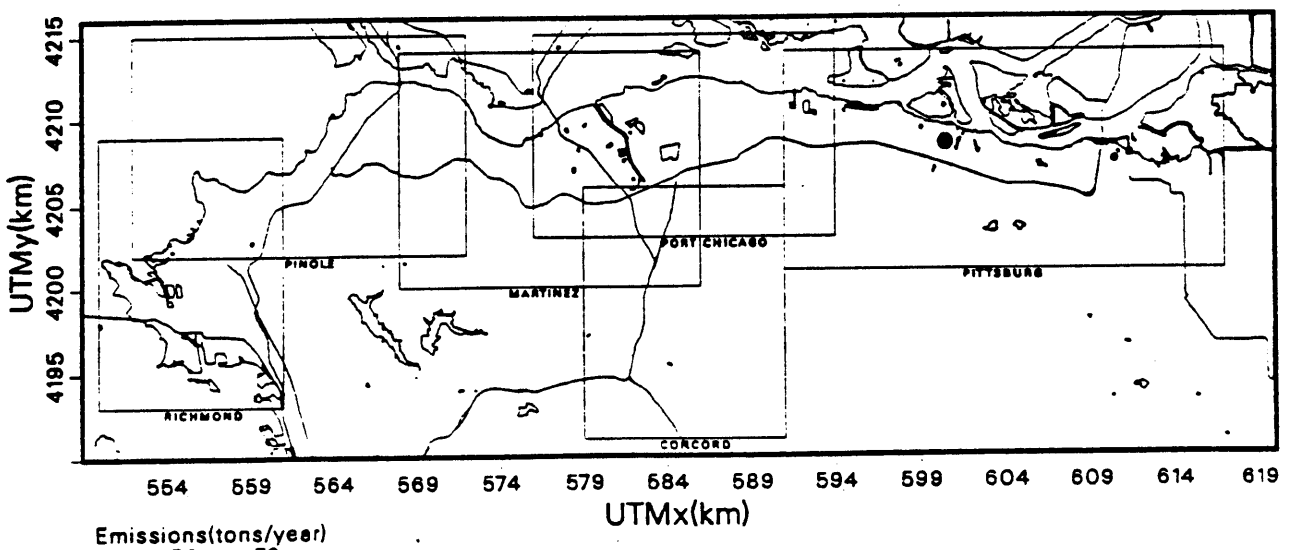
TOTAL EMISSIONS BY GENERAL SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (TPY)

CATEGORY DESCRIPTION	TPY CTET	PERCENT OF TOTAL
CHEMICAL MANUFACTURING	71.79	95.52
OTHER ORGANIC COMPOUNDS EVAPORATION	3.37	4.48

POINT SOURCE INVENTORY FACILITY LISTING

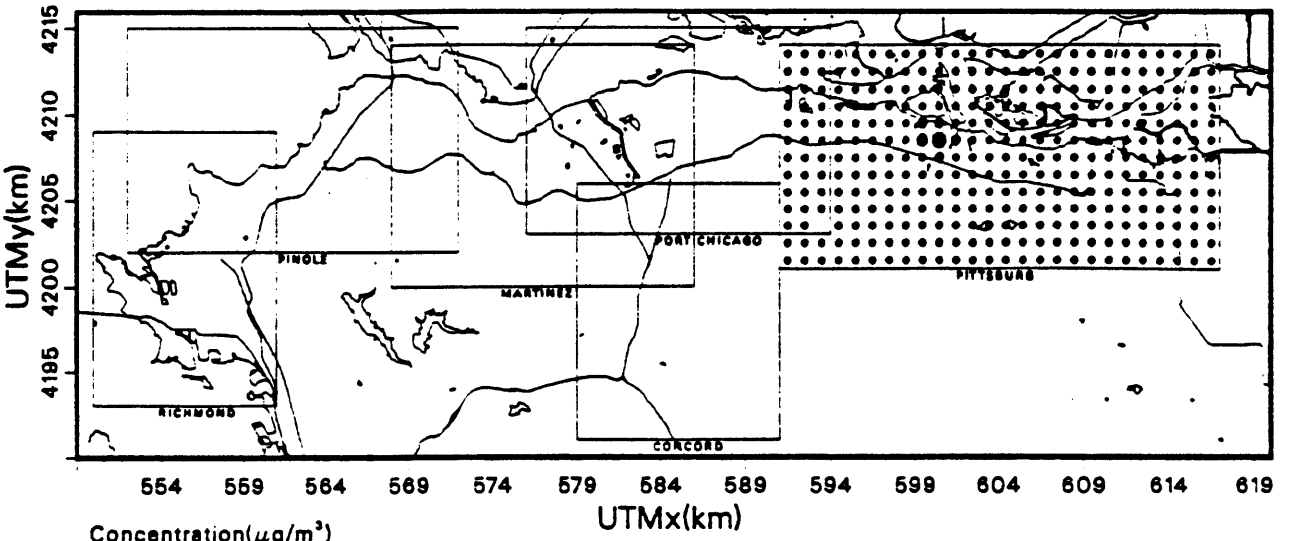
P#	PLANT NAME	CITY	TPY CTET
31	Dow Chemical Company	Pittsburg	68.47
21	E I duPont de Nemours & Company	Antioch	5.28
177	Continental Can Company	Pittsburg	1.40
15	Exxon Corporation	Benicia	.05

CONTRA COSTA COUNTY
EMISSIONS OF CARBON TETRACHLORIDE



Emissions(tons/year)
- ● = 56. - 70.
- ● = 42. - 56.
- ● = 28. - 42.
- • = 14. - 28.
- • = 0.070 - 14.

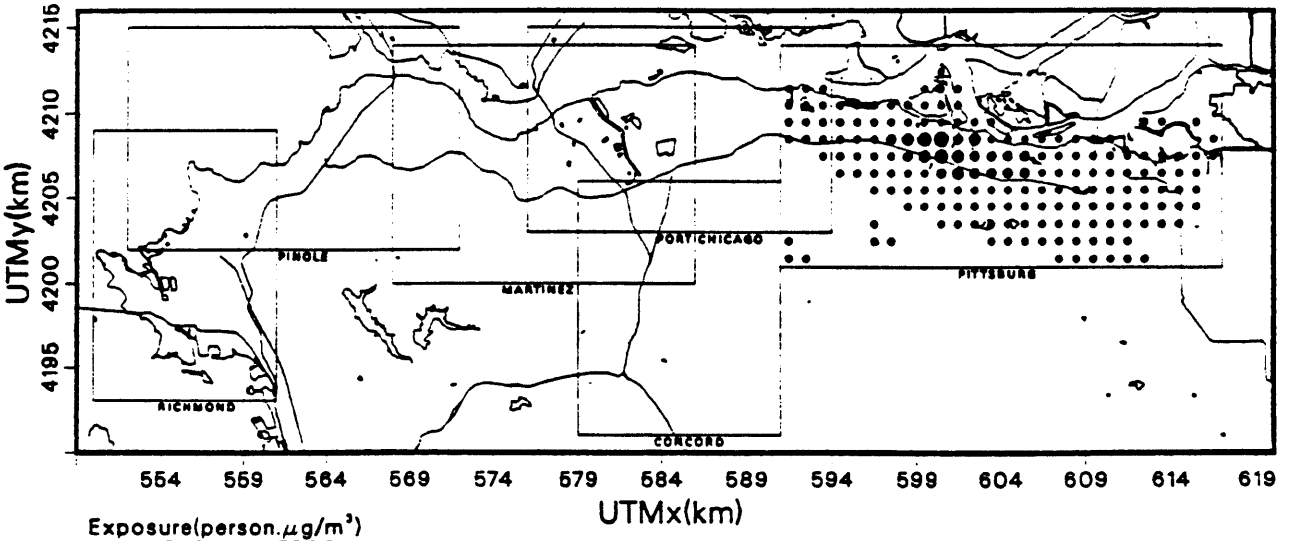
CONTRA COSTA COUNTY
CONCENTRATION OF CARBON TETRACHLORIDE



Concentration($\mu g/m^3$)
- ● = 18. - 23.
- ● = 14. - 18.
- ● = 9.2 - 14.
- ● = 4.6 - 9.2
- • = 0.023 - 4.6

Study Region Average Concentration = 0.195 ug/m3

CONTRA COSTA COUNTY
EXPOSURE TO CARBON TETRACHLORIDE



Exposure(person.$\mu g/m^3$)
- ● = 5600. - 7000.
- ● = 4200. - 5600.
- ● = 2800. - 4200.
- • = 1400. - 2800.
- • = 7.0 - 1400.

Aggregate Exposure = 99.203 person-ug/m3

EMISSIONS INVENTORY SUMMARY
CHLOROFORM

COUNTY	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Contra Costa	3.05	4.11	0.	7.16
Solano	0.	1.19	0.	1.19

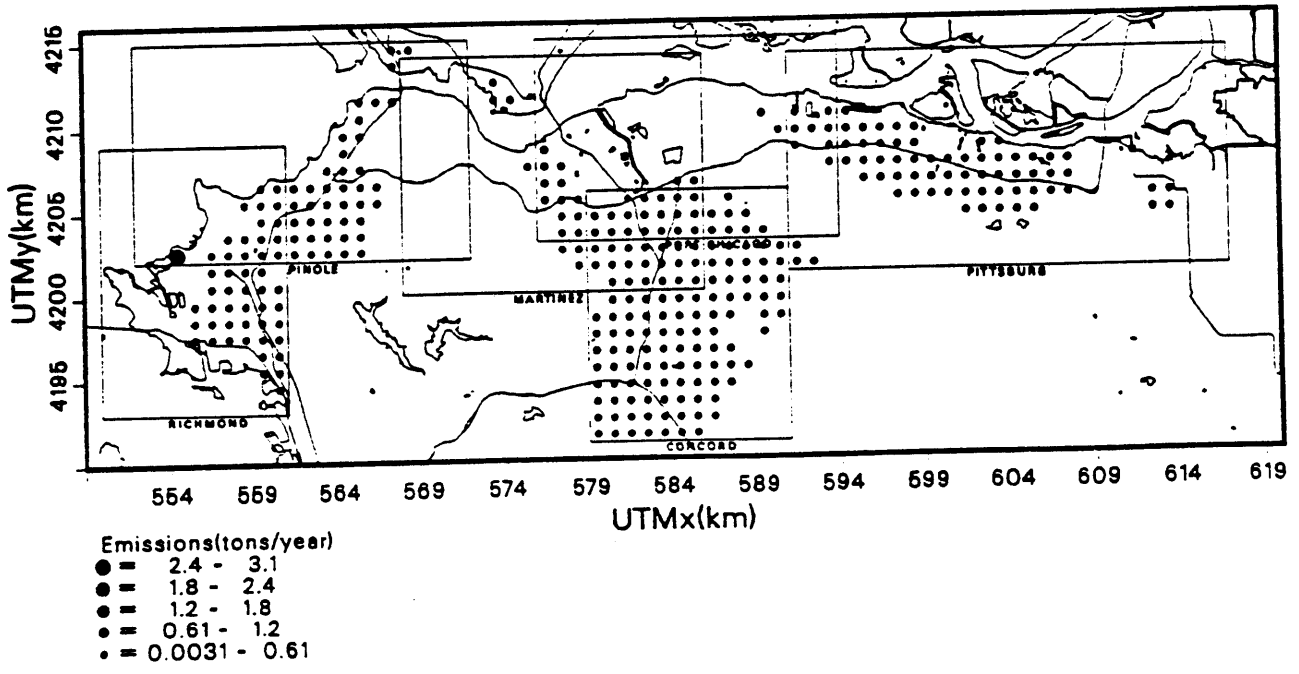
TOTAL EMISSIONS BY GENERAL SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (TPY)

CATEGORY DESCRIPTION	TPY CLFM	PERCENT OF TOTAL
DRINKING WATER CHLORINATION	4.11	57.42
SEWAGE TREATMENT PLANTS	3.05	42.58

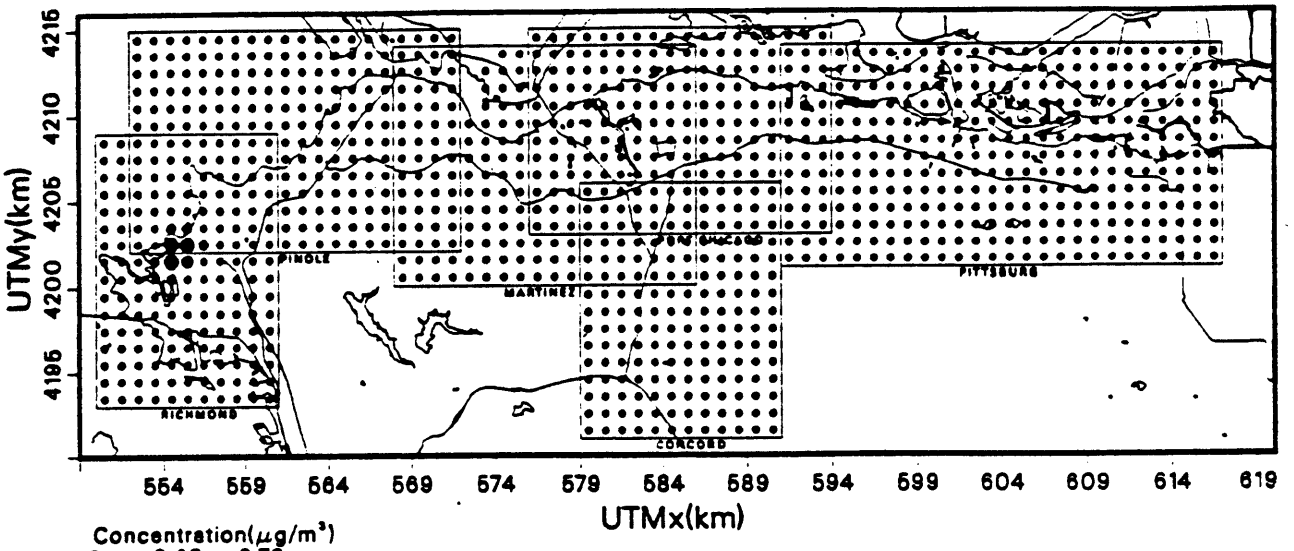
POINT SOURCE INVENTORY FACILITY LISTING

P#	PLANT NAME	CITY	TPY CLFM
9004	Richmond/San Pablo Wastewater Treatment	Richmond	3.05

CONTRA COSTA COUNTY
EMISSIONS OF CHLOROFORM



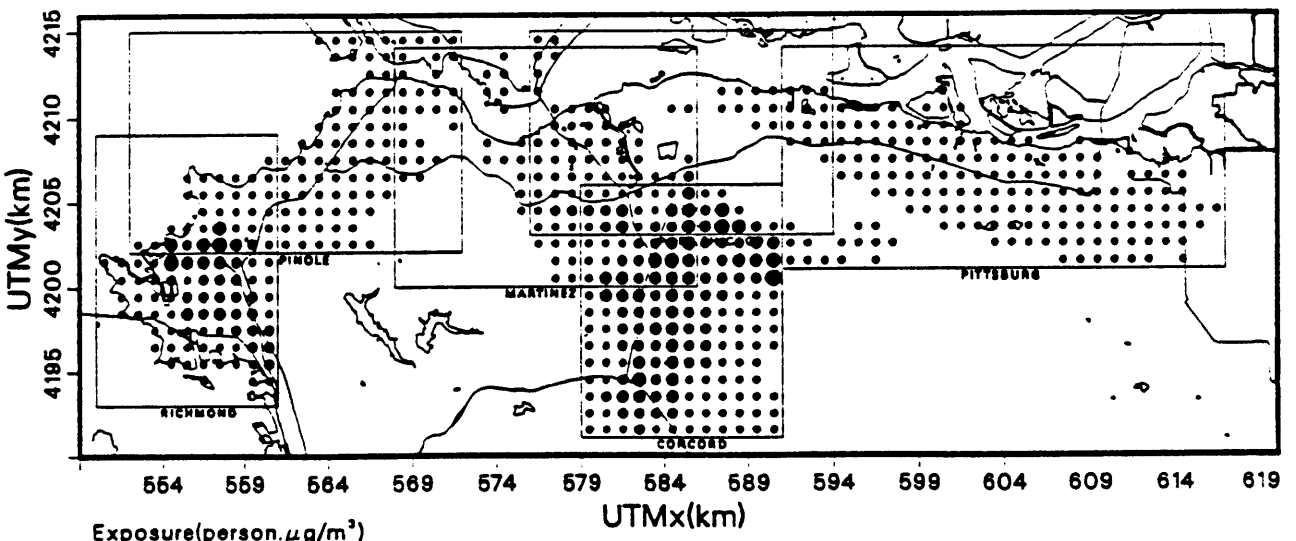
CONTRA COSTA COUNTY
CONCENTRATION OF CHLOROFORM



Concentration($\mu g/m^3$)
- ● = 0.63 - 0.79
- ● = 0.47 - 0.63
- ● = 0.32 - 0.47
- ● = 0.16 - 0.32
- • = 0.0008 - 0.16

Study Region Average Concentration = 0.022 ug/m3

CONTRA COSTA COUNTY
EXPOSURE TO CHLOROFORM



Exposure(person.$\mu g/m^3$)
- ● = 240. - 290.
- ● = 180. - 240.
- ● = 120. - 180.
- ● = 59. - 120.
- • = 0.29 - 59.

Aggregate Exposure = 19,953 person-ug/m3

EMISSIONS INVENTORY SUMMARY
DICHLOROMETHANE (METHYLENE CHLORIDE)

COUNTY	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Contra Costa	66.7	482.0	0.	548.7
Solono	6.1	138.5	0.	144.6

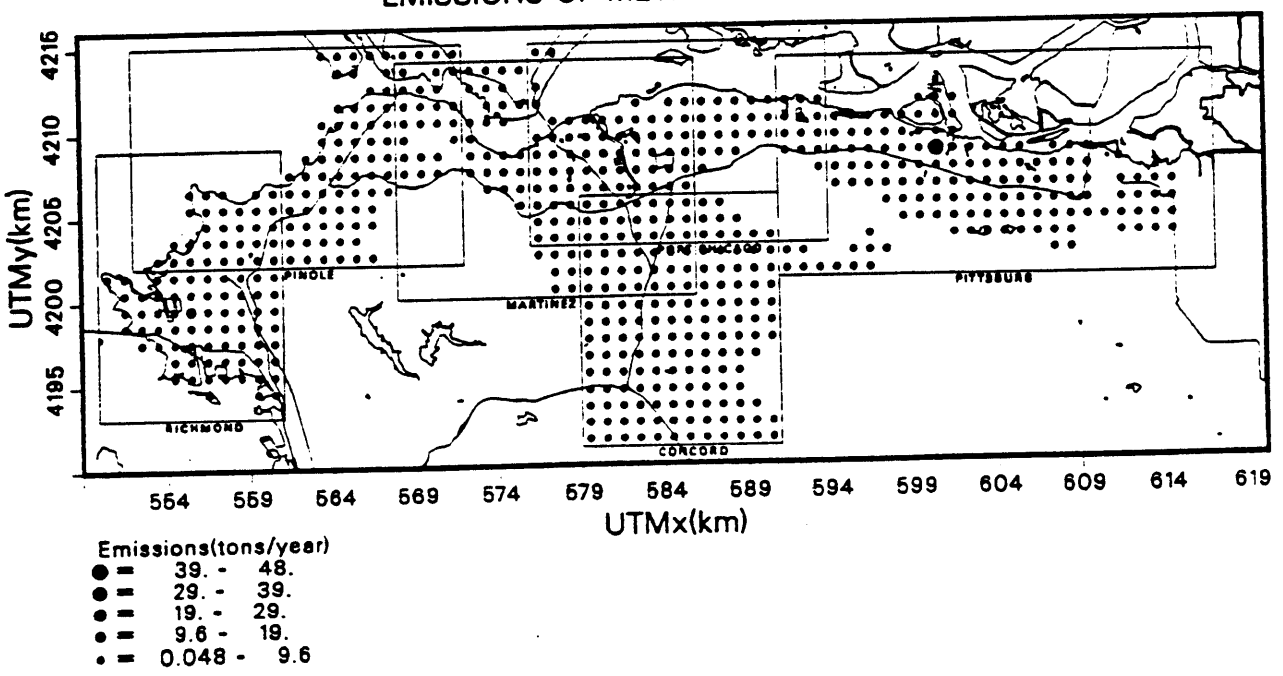
TOTAL EMISSIONS BY GENERAL SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (TPY)

CATEGORY DESCRIPTION	TPY DCLM	PERCENT OF TOTAL
CONSUMER PRODUCTS	318.6	58.08
OTHER ORGANIC COMPOUNDS EVAPORATION	168.9	30.78
CHEMICAL MANUFACTURING	58.3	11.08
SEWAGE TREATMENT PLANTS	2.9	.52

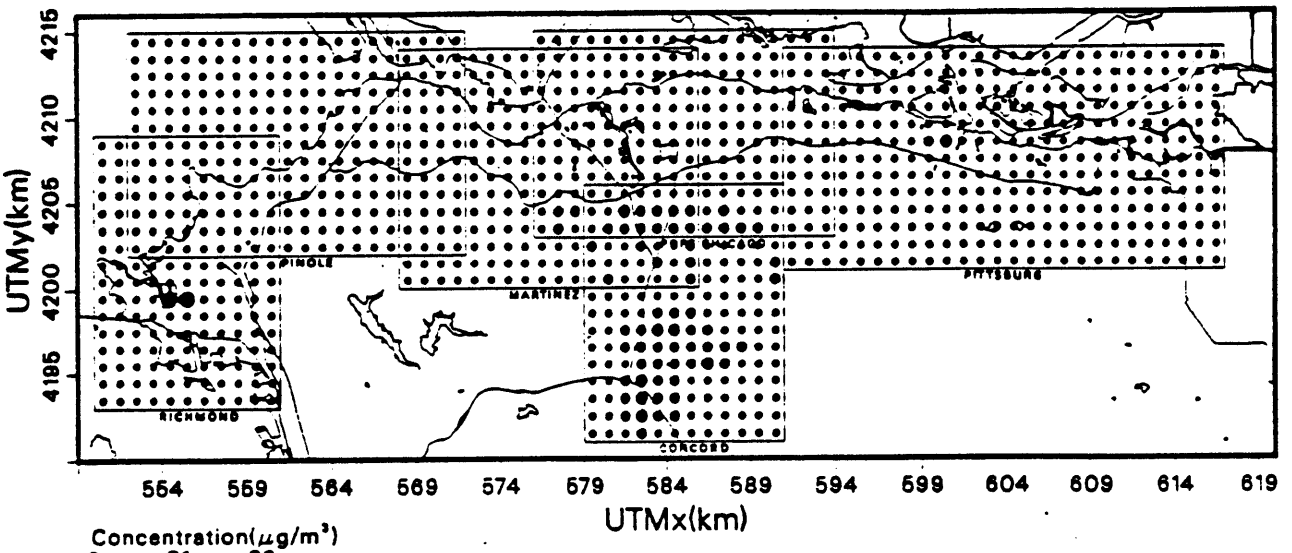
POINT SOURCE INVENTORY FACILITY LISTING

P#	PLANT NAME	CITY	TPY DCLM
31	Dow Chemical Company	Pittsburg	47.84
628	Chevron Chemical Company	Richmond	12.47
770	Travis A F B	Travis AFB	6.05
1836	Veriflo Corporation	Richmond	1.82
1064	Great Western Chemical Company	Richmond	1.69
9004	Richmond/San Pablo Wastewater Treatment	Richmond	1.64
907	Central Contra Costa Sanitary District	Martinez	1.21
1665	National Can Corporation	Fairfield	.03

CONTRA COSTA COUNTY
EMISSIONS OF METHYLENE CHLORIDE



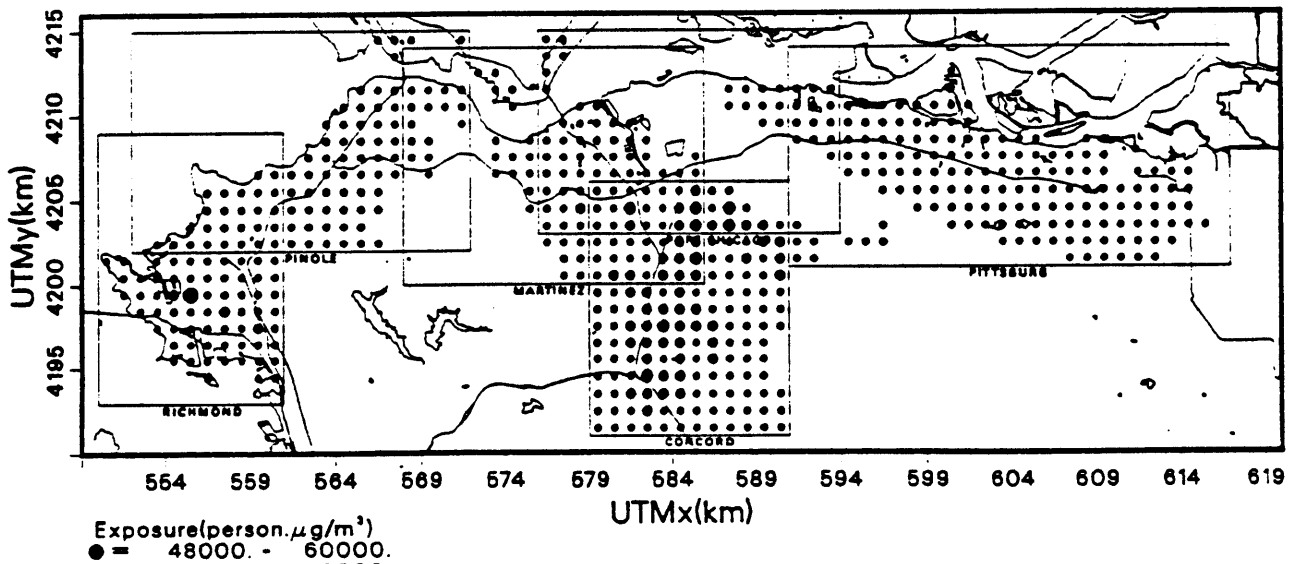
CONTRA COSTA COUNTY
CONCENTRATION OF METHYLENE CHLORIDE



Concentration($\mu g/m^3$)
- ● = 31. - 39.
- ● = 23. - 31.
- ● = 16. - 23.
- • = 7.8 - 16.
- • = 0.039 - 7.8

Study Region Average Concentration = 2.20 ug/m3

CONTRA COSTA COUNTY
EXPOSURE TO METHYLENE CHLORIDE



Exposure(person.$\mu g/m^3$)
- ● = 48000. - 60000.
- ● = 36000. - 48000.
- ● = 24000. - 36000.
- • = 12000. - 24000.
- • = 60. - 12000.

Aggregate Exposure = 2,210,161 person-ug/m3

EMISSIONS INVENTORY SUMMARY
1,4 - DIOXANE

COUNTY	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Contra Costa	0.60	3.22	0.	3.82
Solano	0.18	0.87	0.	1.05

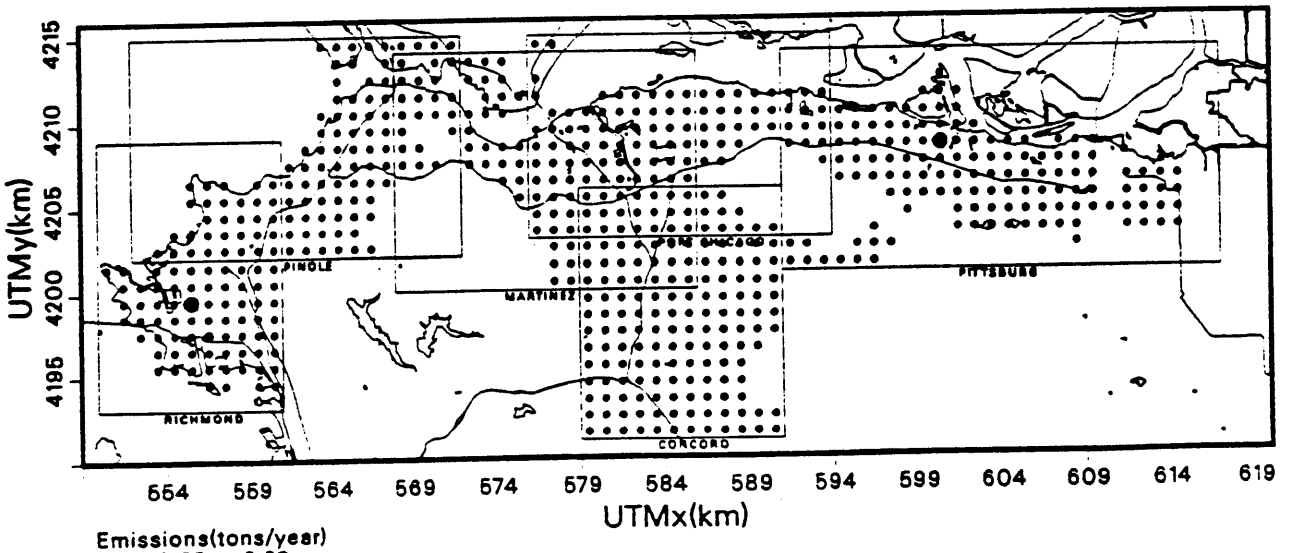
TOTAL EMISSIONS BY GENERAL SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (TPY)

CATEGORY DESCRIPTION	TPY DIOX	PERCENT OF TOTAL
OTHER ORGANIC COMPOUNDS EVAPORATION	2.409	63.11
CONSUMER PRODUCTS	1.408	36.89

POINT SOURCE INVENTORY FACILITY LISTING (TOP 10)

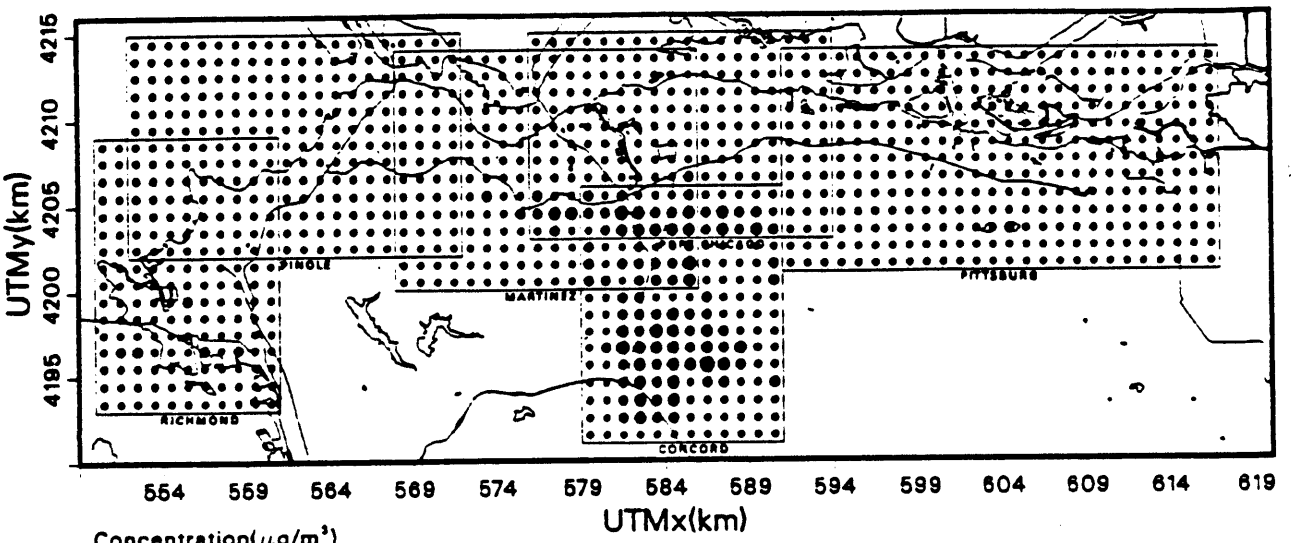
P#	PLANT NAME	CITY	TPY DIOX
31	Dow Chemical Company	Pittsburg	.270
457	Amot Controls Corporation	Richmond	.266
2609	J R Schneider Company, Inc	Benicia	.166
1800	Pilgrim Fireplace Equipment Company	Richmond	.046
911	Hysol Div - The Dexter Corporation	Pittsburg	.010
1844	Monarch Norcal	Vallejo	.010
1064	Great Western Chemical Company	Richmond	.007
1987	Diesel Systems, Inc	Benicia	.005
770	Travis A F B	Travis AFB	.002
2794	Airco Solar Products	Fairfield	.002

CONTRA COSTA COUNTY
EMISSIONS OF 1,4-DIOXANE



Emissions(tons/year)
- ● = 0.22 - 0.28
- ● = 0.17 - 0.22
- ● = 0.11 - 0.17
- • = 0.056 - 0.11
- • = 0.0003 - 0.056

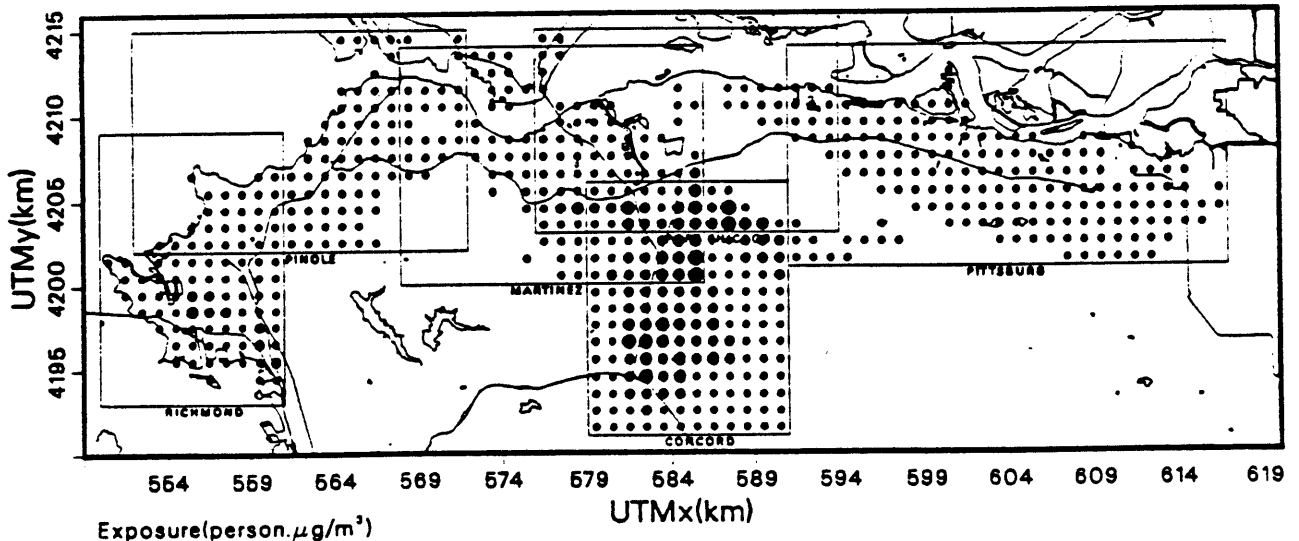
CONTRA COSTA COUNTY
CONCENTRATION OF 1,4-DIOXANE



Concentration($\mu g/m^3$)
- ● = 0.15 - 0.19
- ● = 0.11 - 0.15
- ● = 0.075 - 0.11
- • = 0.038 - 0.075
- • = 0.0002 - 0.038

Study Region Average Concentration = 0.015 ug/m3

CONTRA COSTA COUNTY
EXPOSURE TO 1,4-DIOXANE



Exposure(person.$\mu g/m^3$)
- ● = 220. - 270.
- ● = 160. - 220.
- ● = 110. - 160.
- • = 54. - 110.
- • = 0.27 - 54.

Aggregate Exposure = 14,441 person-ug/m3

EMISSIONS INVENTORY SUMMARY
ETHYLENE DIBROMIDE

COUNTY	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Contra Costa	0.01	0.07	0.06	0.14
Solano	0.00	0.04	0.02	0.06

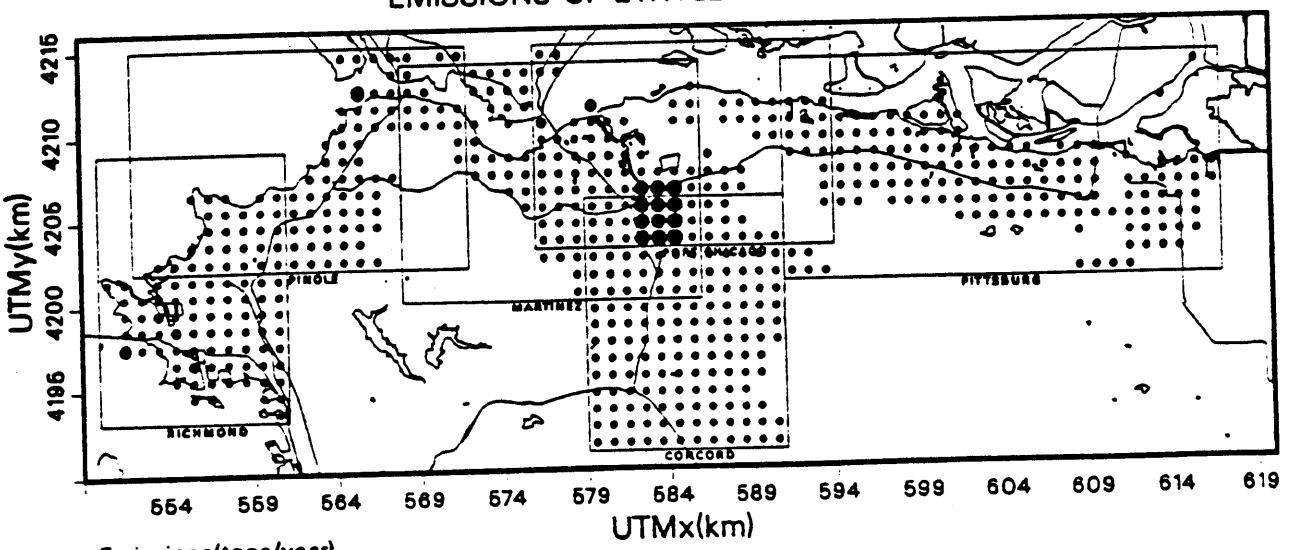
TOTAL EMISSIONS BY GENERAL SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (TPY)

CATEGORY DESCRIPTION	TPY EDB	PERCENT OF TOTAL
ON-ROAD MOBILE SOURCES	.058	41.37
AIRCRAFT	.029	21.13
OFF-ROAD MOBILE SOURCES	.029	20.71
STATIONARY FUEL COMBUSTION	.013	9.38
PETROLEUM REFINERY EVAPORATION	.007	5.08
FUELS DISTRIBUTION	.003	2.15
OTHER ORGANIC COMPOUNDS EVAPORATION	<.001	.18

POINT SOURCE INVENTORY FACILITY LISTING (TOP 10)

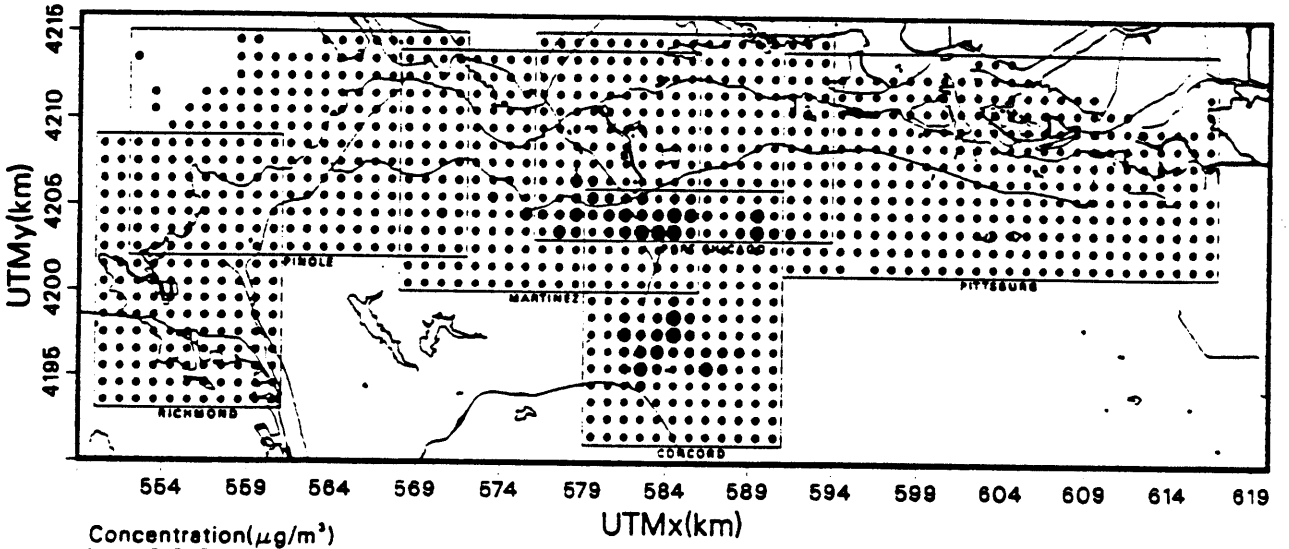
P#	PLANT NAME	CITY	TPY EDB
10	Chevron USA, Inc	Richmond	.0024
13	Tosco Corp, Avon Refinery	Martinez	.0020
16	Union Oil Company	Rodeo	.0018
72	Chevron U S A Inc	Richmond	.0008
15	Exxon Corporation	Benicia	.0007
32	Pacific Refining Company	Hercules	.0007
3158	Martinez Terminals Limited	Martinez	.0003
57	Atlantic Richfield Company	Richmond	.0003
581	Wickland Oil Terminal	Crockett	.0003
61	Union Oil Co of California	Richmond	.0002

CONTRA COSTA COUNTY
EMISSIONS OF ETHYLENE DIBROMIDE



Emissions(tons/year)
- ● = 0.0022 - 0.0028
- ● = 0.0017 - 0.0022
- ● = 0.0011 - 0.0017
- • = 0.00055 - 0.0011
- • = 0.000003 - 0.00055

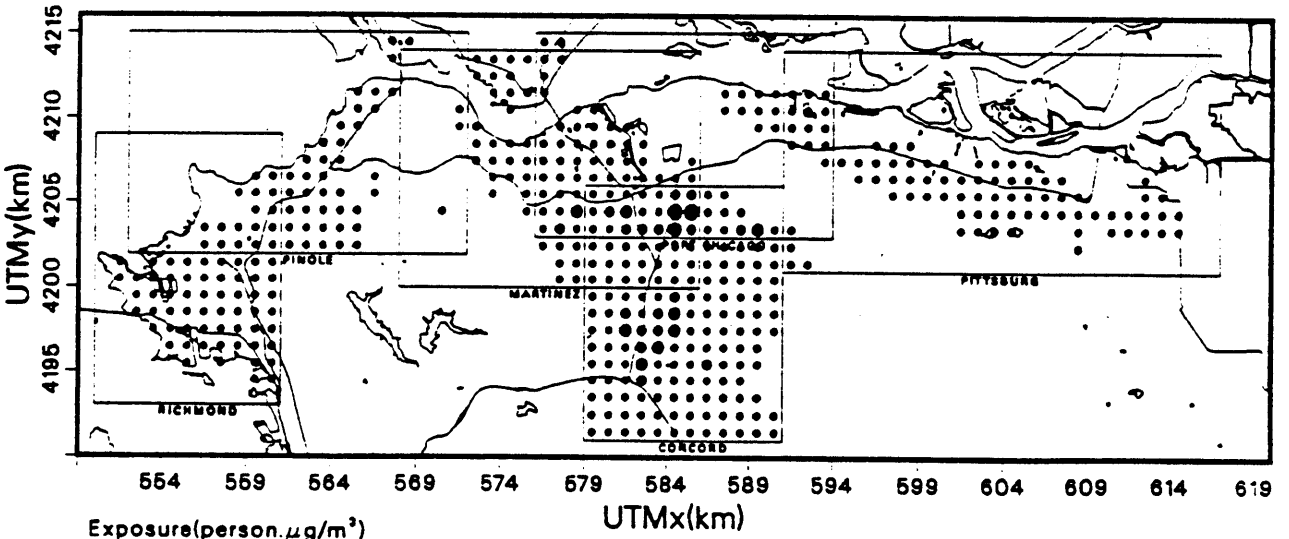
CONTRA COSTA COUNTY
CONCENTRATION OF ETHYLENE DIBROMIDE



Concentration($\mu g/m^3$)
- ● = 0.010 - 0.013
- ● = 0.0076 - 0.010
- ● = 0.0051 - 0.0076
- • = 0.0025 - 0.0051
- • = 0.00001 - 0.0025

Study Region Average Concentration = 0.0006 ug/m3

CONTRA COSTA COUNTY
EXPOSURE TO ETHYLENE DIBROMIDE



Exposure(person.$\mu g/m^3$)
- ● = 21. - 26.
- ● = 15. - 21.
- ● = 10. - 15.
- • = 5.2 - 10.
- • = 0.026 - 5.2

Aggregate Exposure = 637 person-ug/m3

EMISSIONS INVENTORY SUMMARY
ETHYLENE OXIDE

COUNTY	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Contra Costa	1.59	0.	0.	1.59
Solano	0.21	0.	0.	0.21

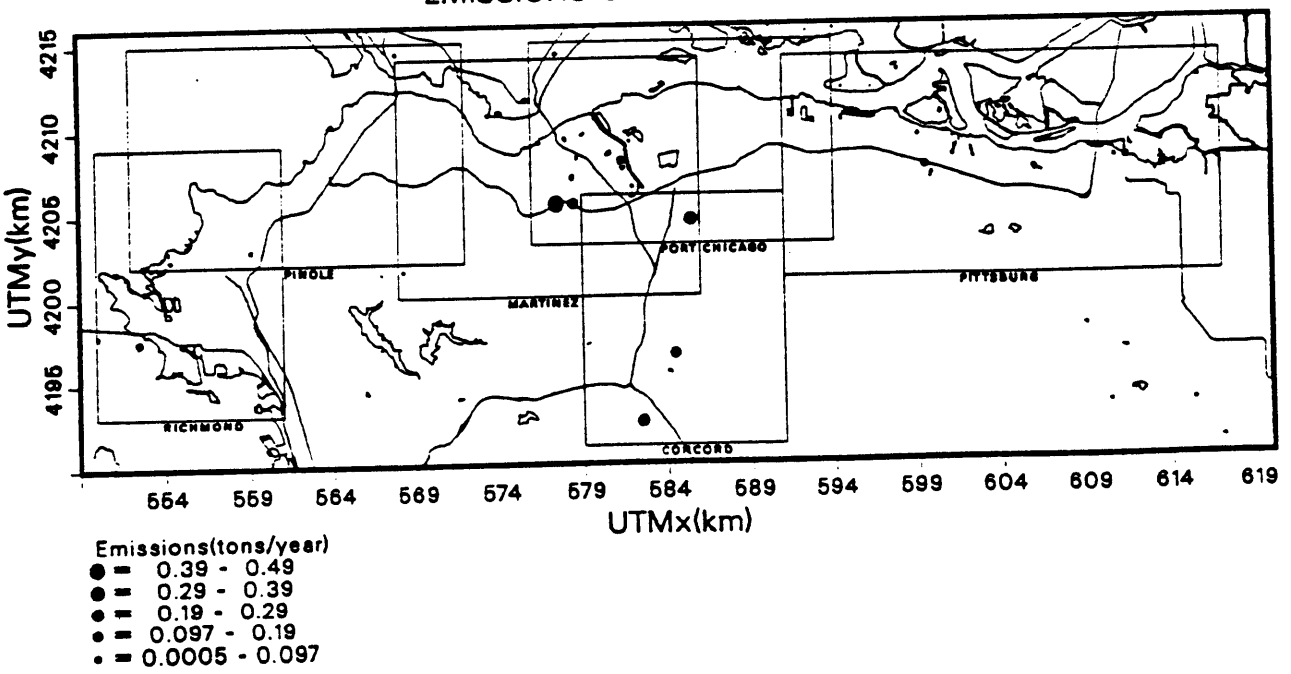
TOTAL EMISSIONS BY GENERAL SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (TPY)

CATEGORY DESCRIPTION	TPY ETOX	PERCENT OF TOTAL
HOSPITAL STERILIZERS	1.580	99.39
OTHER ORGANIC COMPOUNDS EVAPORATION	.010	.61

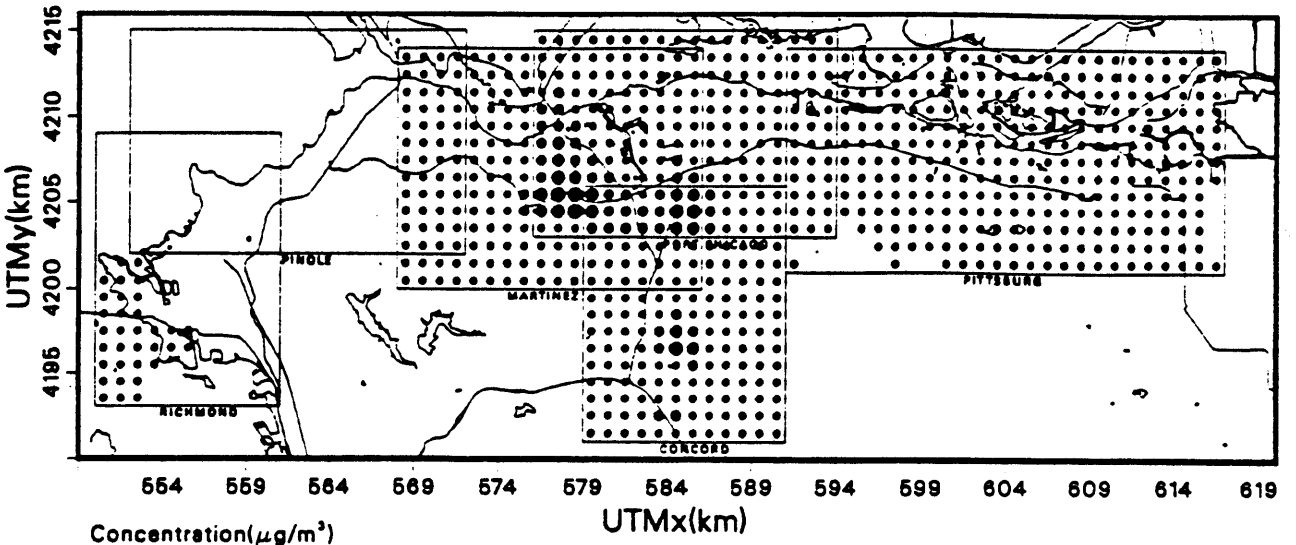
POINT SOURCE INVENTORY FACILITY LISTING

P#	PLANT NAME	CITY	TPY ETOX
9003	VA Hospital	Martinez	.486
508	Brookside Hospital	San Pablo	.319
1753	Mount Diablo Hospital Medical Center	Concord	.243
1821	Kaiser Foundation Hospital	Walnut Creek	.194
2133	John Muir Memorial Hospital	Walnut Creek	.157
9000	Kaiser Foundation Hospital	Vallejo	.146
1669	Kaiser Permanente Medical Center	Martinez	.097
9001	Los Medanos Community Hospital	Pittsburg	.082
9002	Northbay Medical Center	Fairfield	.061
1064	Great Western Chemical Company	Richmond	.010

CONTRA COSTA COUNTY
EMISSIONS OF ETHYLENE OXIDE



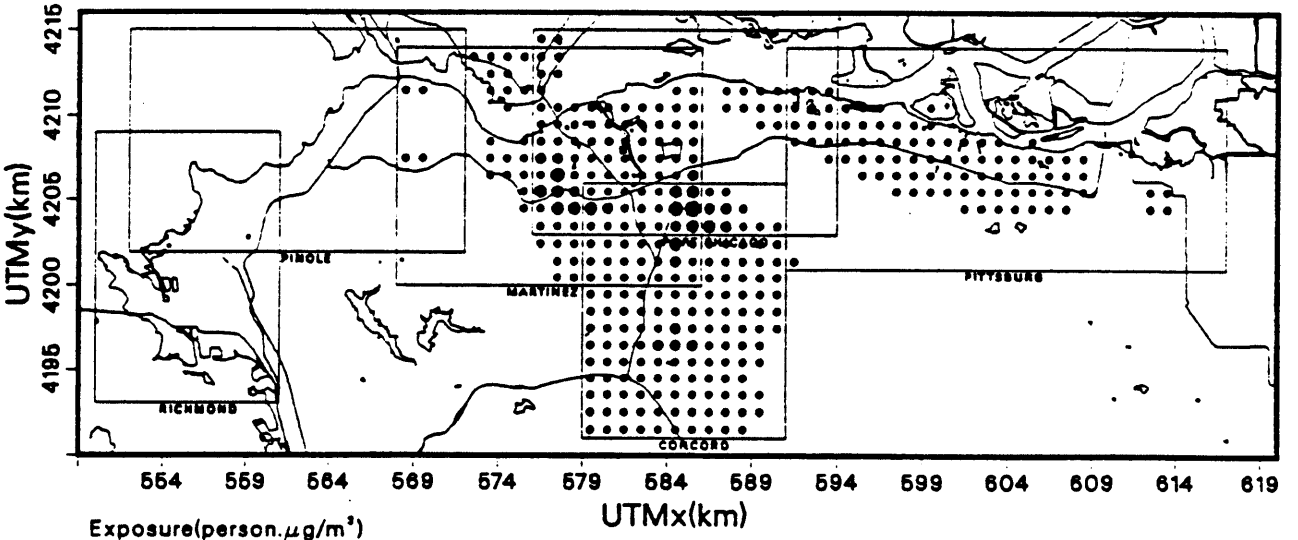
CONTRA COSTA COUNTY
CONCENTRATION OF ETHYLENE OXIDE



Concentration($\mu g/m^3$)
- ● = 0.044 - 0.055
- ● = 0.033 - 0.044
- ● = 0.022 - 0.033
- ● = 0.011 - 0.022
- • = 0.00005 - 0.011

Study Region Average Concentration = 0.0026 ug/m3

CONTRA COSTA COUNTY
EXPOSURE TO ETHYLENE OXIDE



Exposure(person.$\mu g/m^3$)
- ● = 86. - 110.
- ● = 64. - 86.
- ● = 43. - 64.
- • = 21. - 43.
- • = 0.11 - 21.

Aggregate Exposure = 2,455 person-ug/m3

EMISSIONS INVENTORY SUMMARY
FORMALDEHYDE

COUNTY	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Contra Costa	54.6	221.9	162.8	439.3
Solano	5.9	99.7	69.5	175.1

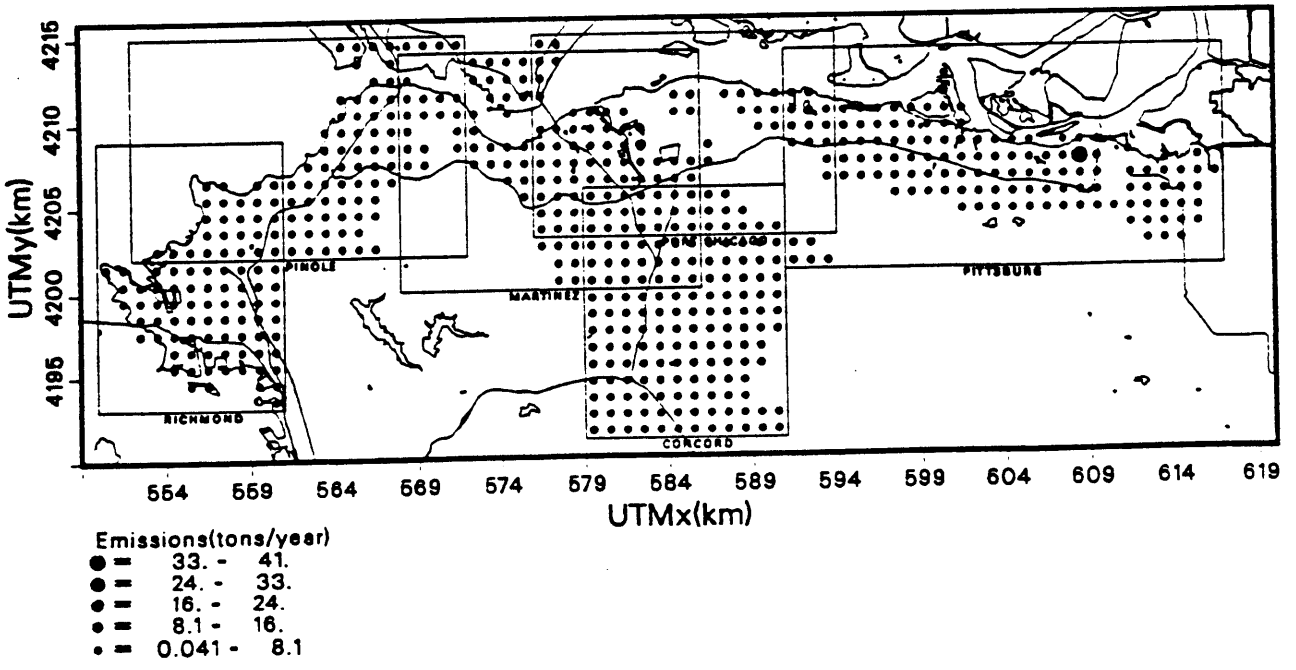
TOTAL EMISSIONS BY GENERAL SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (TPY)

CATEGORY DESCRIPTION	TPY FMLD	PERCENT OF TOTAL
STATIONARY FUEL COMBUSTION	204.9	46.64
ON-ROAD MOBILE SOURCES	162.8	37.06
OFF-ROAD MOBILE SOURCES	30.0	6.83
MISCELLANEOUS EMISSION SOURCES	14.4	3.27
PETROLEUM REFINING	11.1	2.52
BURNING OF WASTE MATERIAL	10.6	2.42
OTHER ORGANIC COMPOUNDS EVAPORATION	3.7	.84
AIRCRAFT	1.8	.41

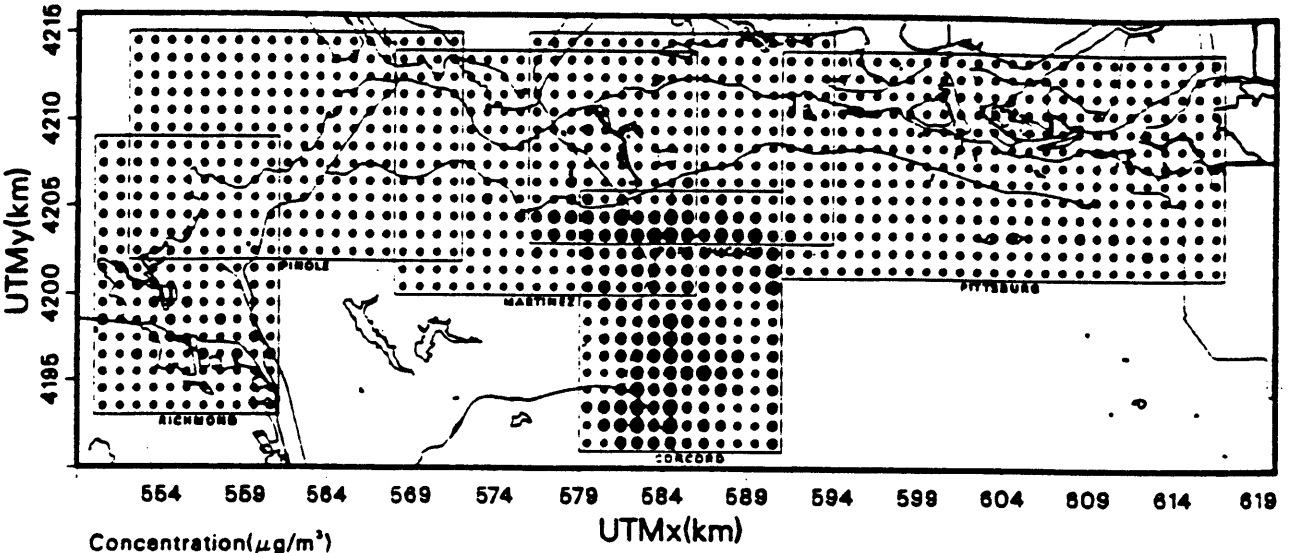
POINT SOURCE INVENTORY FACILITY LISTING (TOP 10)

Pf	PLANT NAME	CITY	TPY FMLD
19	Louisiana-Pacific Corporation	Antioch	40.51
13	Tosco Corp, Avon Refinery	Martinez	8.27
15	Exxon Corporation	Benicia	5.83
11	Shell Oil Company	Martinez	4.29
10	Chevron USA, Inc	Richmond	1.00
33	California & Hawaiian Sugar Company	Crockett	.11
907	Central Contra Costa Sanitary Distric	Martinez	.10
16	Union Oil Company	Rodeo	.09
12	Pacific Gas & Electric Company	Pittsburg	.06
606	Anheuser-Busch, Inc	Fairfield	.04

CONTRA COSTA COUNTY
EMISSIONS OF FORMALDEHYDE



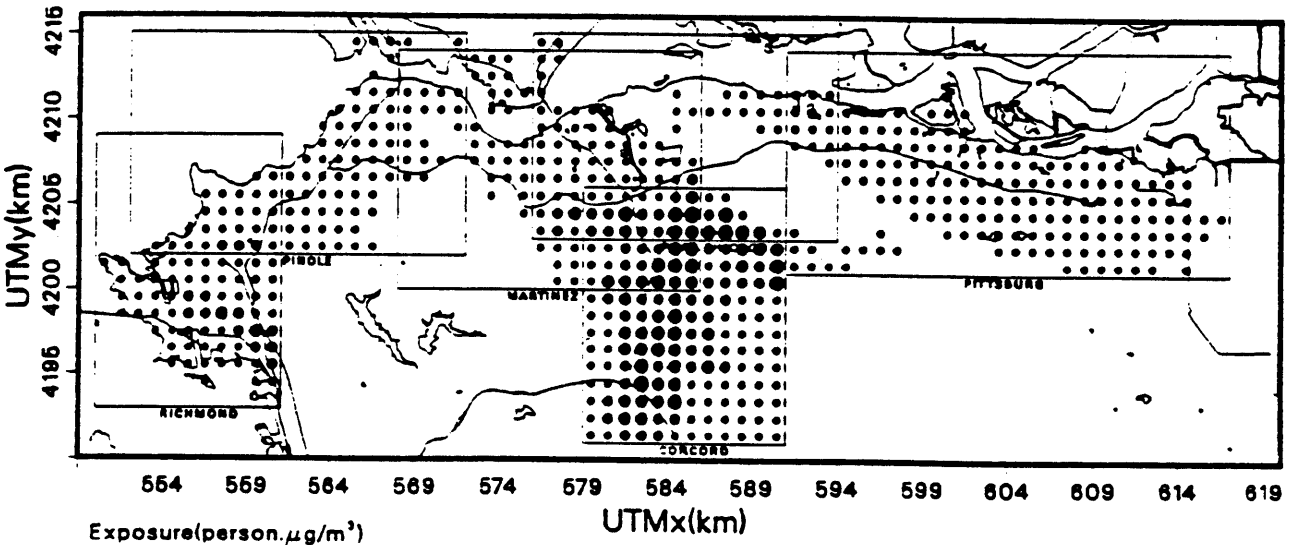
CONTRA COSTA COUNTY
CONCENTRATION OF FORMALDEHYDE



Concentration($\mu g/m^3$)
- ● = 9.4 - 12.
- ● = 7.1 - 9.4
- ● = 4.7 - 7.1
- • = 2.4 - 4.7
- • = 0.012 - 2.4

Study Region Average Concentration = 1.24 ug/m3

CONTRA COSTA COUNTY
EXPOSURE TO FORMALDEHYDE



Exposure(person.$\mu g/m^3$)
- ● = 16000. - 20000.
- ● = 12000. - 16000.
- ● = 8000. - 12000.
- • = 4000. - 8000.
- • = 20. - 4000.

Aggregate Exposure = 1,329,637 person-ug/m3

EMISSIONS INVENTORY SUMMARY
PERCHLOROETHYLENE

COUNTY	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Contra Costa	91.5	187.6	0.	279.1
Solano	5.4	34.7	0.	40.1

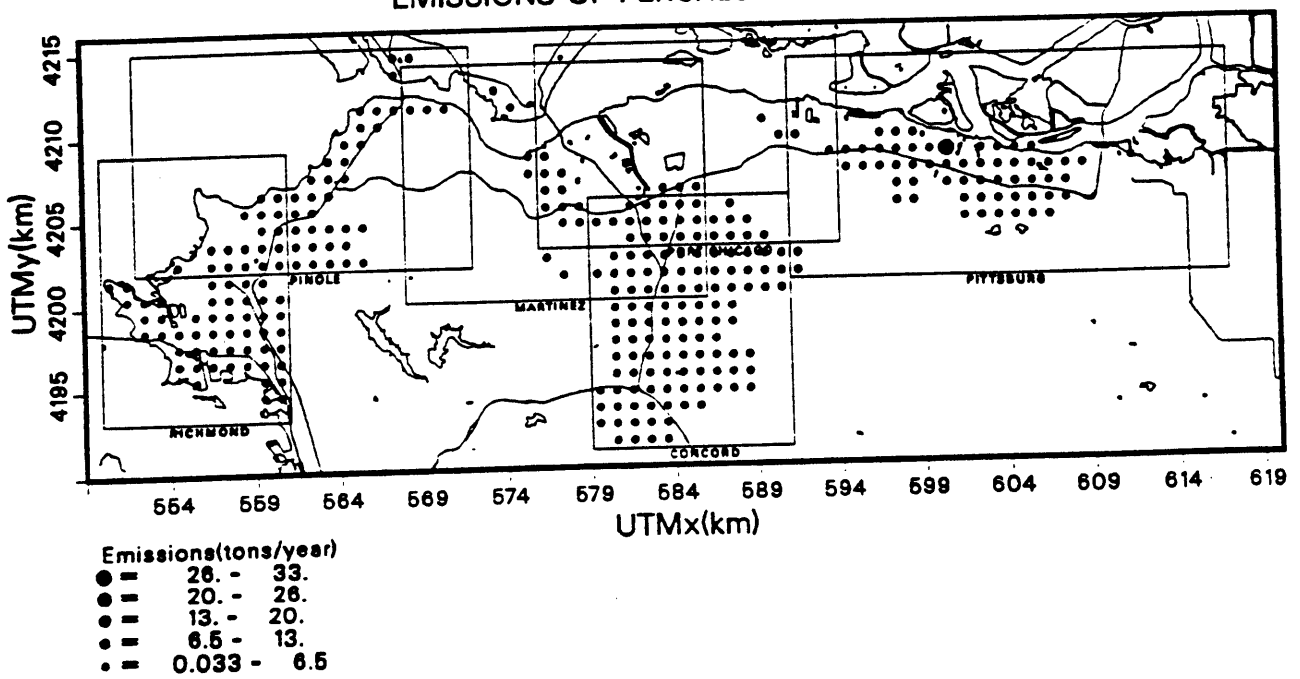
TOTAL EMISSIONS BY GENERAL SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (TPY)

CATEGORY DESCRIPTION	TPY PERC	PERCENT OF TOTAL
DRY CLEANERS	154.3	55.28
CONSUMER PRODUCTS	66.1	23.70
CHEMICAL MANUFACTURING	32.6	11.67
OTHER ORGANIC COMPOUNDS EVAPORATION	25.5	9.15
SEWAGE TREATMENT PLANTS	.6	.20

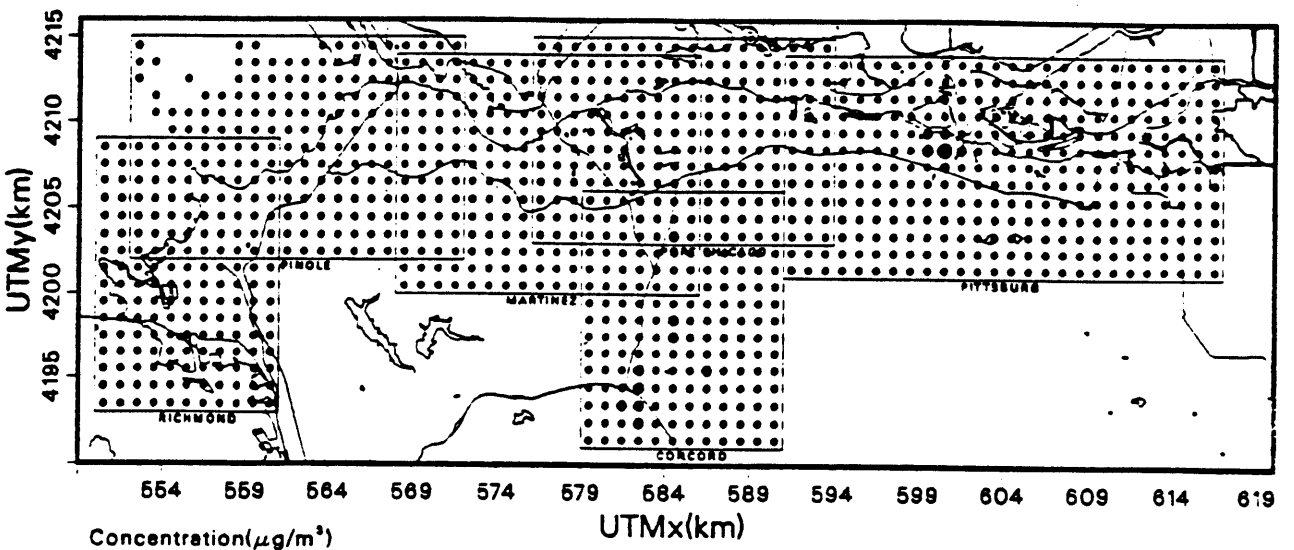
POINT SOURCE INVENTORY FACILITY LISTING (TOP 10)

P#	PLANT NAME	CITY	TPY PERC
31	Dow Chemical Company	Pittsburg	32.86
314	Mercury Dry Cleaners	Pinole	7.96
2178	Sunshine Cleaners & Coin Laundry	El Cerrito	7.87
325	De Freitas Coin Op.	Lafayette	6.75
414	Orinda Martinizing Cleaners	Orinda	4.50
319	Norge Cleaners	Walnut Creek	4.28
332	Treat Cleaners	Concord	3.50
1295	West Cleaners	Antioch	3.04
2693	Marvel Dry Cleaners	Concord	2.86
365	Orchid Cleaners	Fairfield	2.45

CONTRA COSTA COUNTY
EMISSIONS OF PERCHLOROETHYLENE



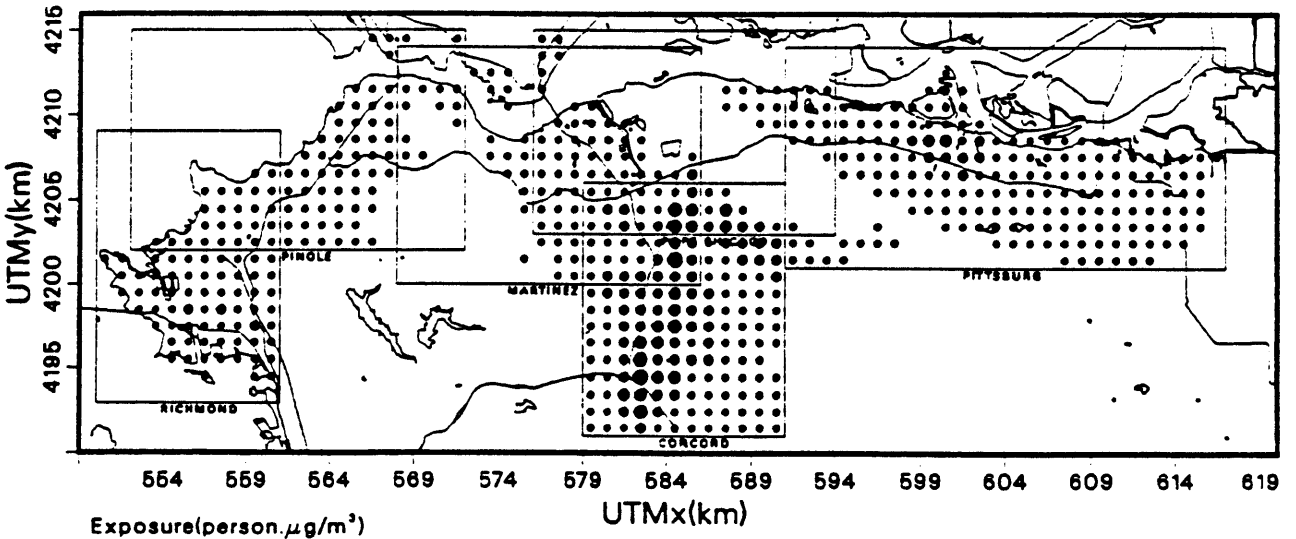
CONTRA COSTA COUNTY
CONCENTRATION OF PERCHLOROETHYLENE



Concentration($\mu g/m^3$)
- ● = 30. - 37.
- ● = 22. - 30.
- ● = 15. - 22.
- • = 7.4 - 15.
- • = 0.037 - 7.4

Study Region Average Concentration = 1.13 ug/m3

CONTRA COSTA COUNTY
EXPOSURE TO PERCHLOROETHYLENE



Exposure(person.$\mu g/m^3$)
- ● = 17000. - 21000.
- ● = 12000. - 17000.
- ● = 8300. - 12000.
- • = 4100. - 8300.
- • = 21. - 4100.

Aggregate Exposure = 1,071,399 person-ug/m3

EMISSIONS INVENTORY SUMMARY
PHENOL

COUNTY	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Contra Costa	168.2	97.9	0.	266.1
Solano	0.	24.5	0.	24.5

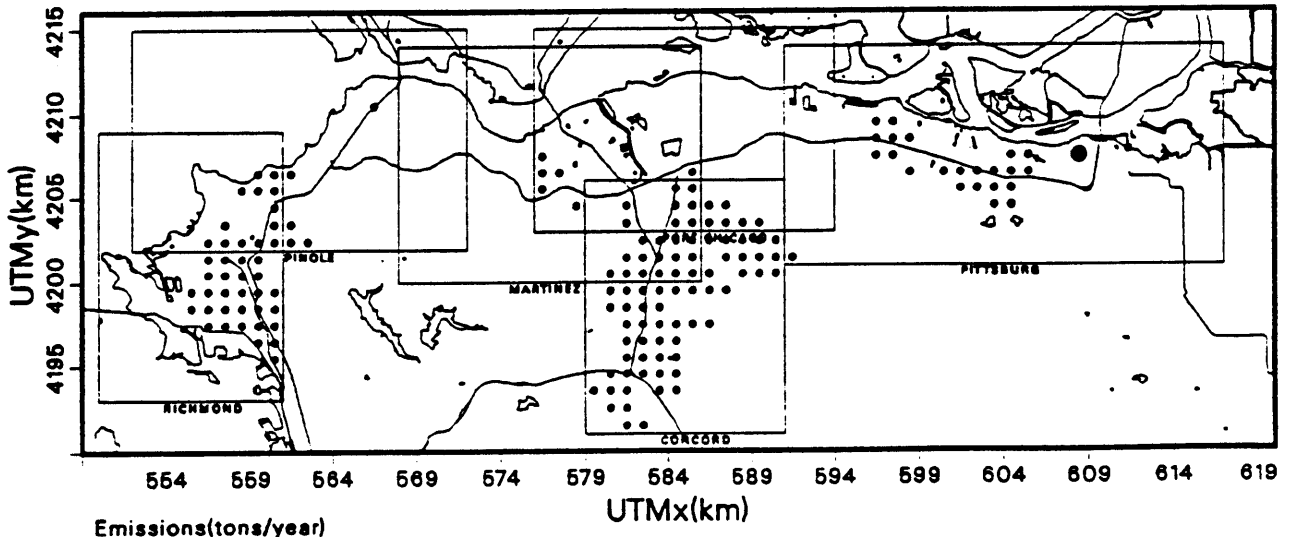
TOTAL EMISSIONS BY GENERAL SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (TPY)

CATEGORY DESCRIPTION	TPY PHNL	PERCENT OF TOTAL
STATIONARY FUEL COMBUSTION	265.9	99.93
PETROLEUM REFINERY EVAPORATION	.2	.07

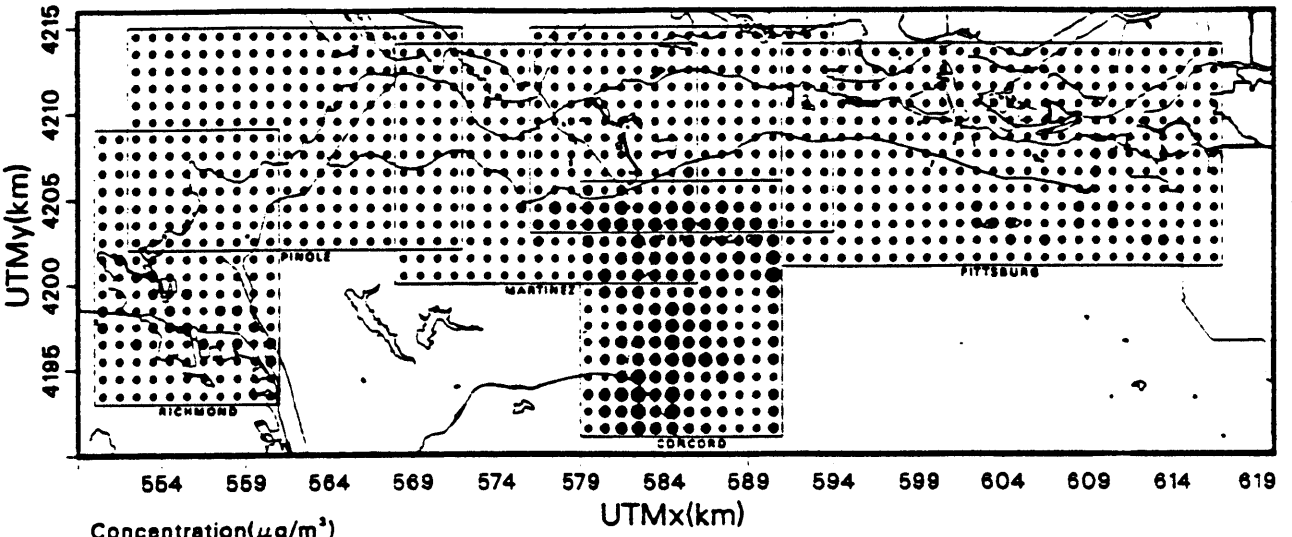
POINT SOURCE INVENTORY FACILITY LISTING

P#	PLANT NAME	CITY	TPY PHNL
19	Louisiana-Pacific Corporation	Antioch	167.99
16	Union Oil Company	Rodeo	.13
10	Chevron USA, Inc	Richmond	.07

CONTRA COSTA COUNTY
EMISSIONS OF PHENOL



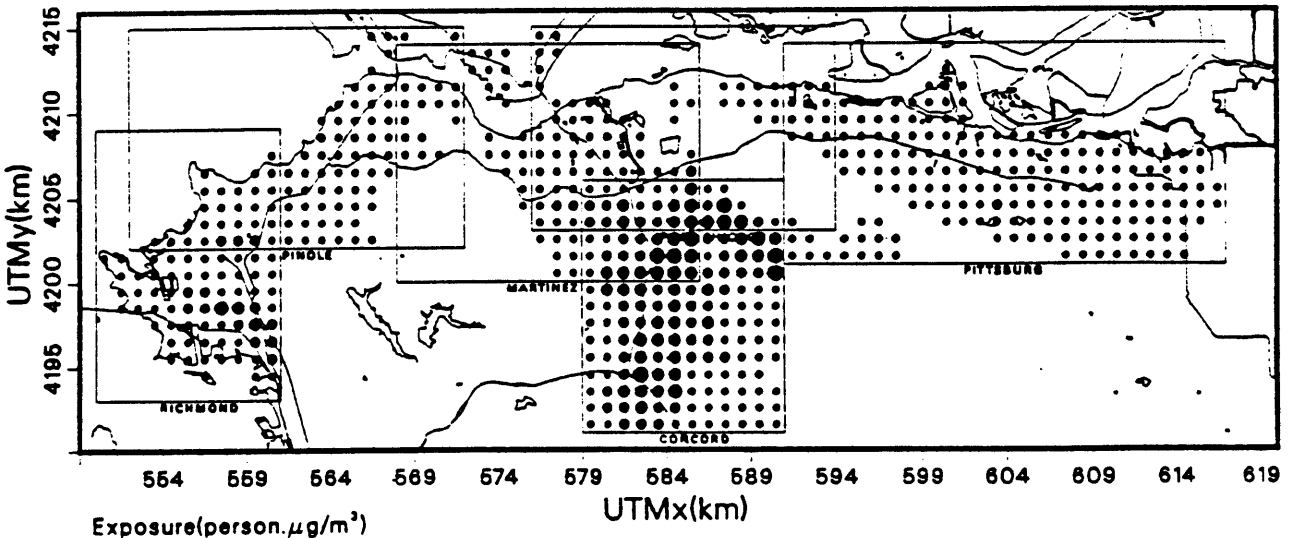
CONTRA COSTA COUNTY
CONCENTRATION OF PHENOL



Concentration($\mu g/m^3$)
- ● = 2.9 - 3.6
- ● = 2.2 - 2.9
- ● = 1.4 - 2.2
- ● = 0.72 - 1.4
- • = 0.0036 - 0.72

Study Region Average Concentration = 0.40 ug/m3

CONTRA COSTA COUNTY
EXPOSURE TO PHENOL



Exposure(person.$\mu g/m^3$)
- ● = 4900. - 6200.
- ● = 3700. - 4900.
- ● = 2500. - 3700.
- • = 1200. - 2500.
- • = 6.2 - 1200.

Aggregate Exposure = 416,079 person-ug/m3

EMISSIONS INVENTORY SUMMARY
TRICHLOROETHYLENE

COUNTY	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Contra Costa	1.88	2.94	0.	4.82
Solano	0.05	0.51	0.	0.56

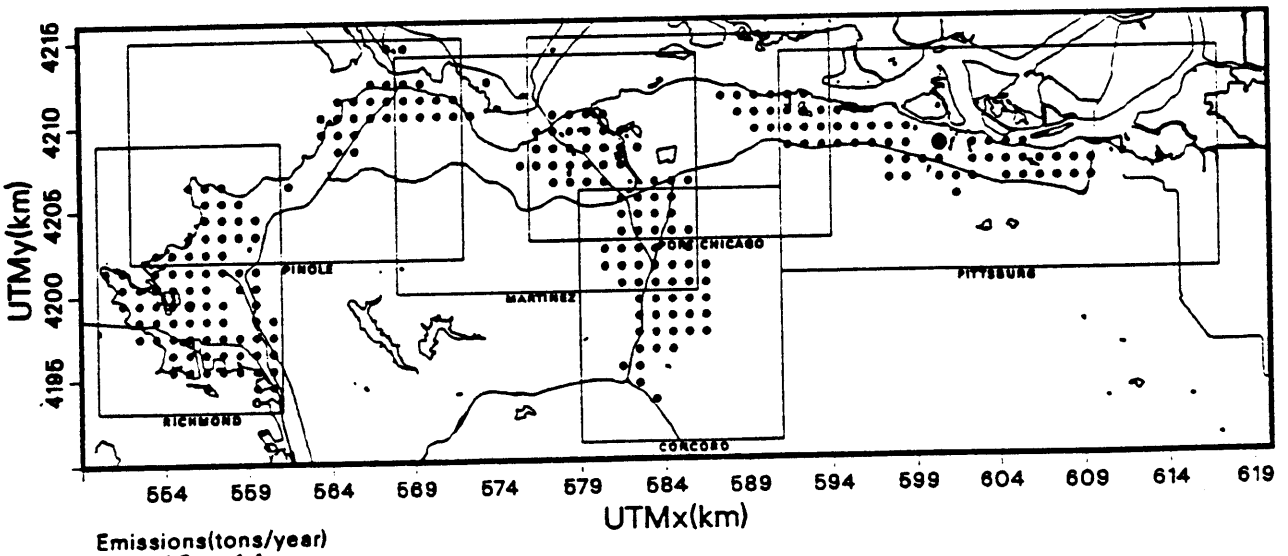
TOTAL EMISSIONS BY GENERAL SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (TPY)

CATEGORY DESCRIPTION	TPY TCE	PERCENT OF TOTAL
OTHER ORGANIC COMPOUNDS EVAPORATION	4.790	99.38
SEWAGE TREATMENT PLANTS	.030	.62

POINT SOURCE INVENTORY FACILITY LISTING

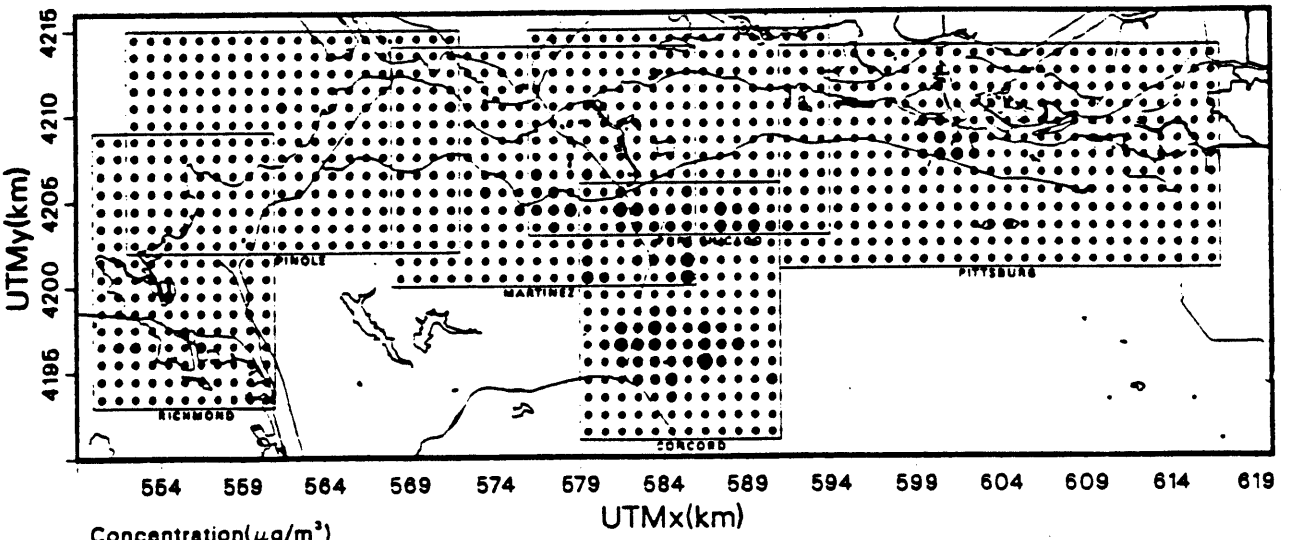
P#	PLANT NAME	CITY	TPY TCE
31	Dow Chemical Company	Pittsburg	1.440
628	Chevron Chemical Company	Richmond	.322
1064	Great Western Chemical Company	Richmond	.077
44	Mare Island Naval Shipyard	Vallejo	.052
9004	Richmond/San Pablo Wastewater Treatment	Richmond	.030
423	Chevron Research Company	Richmond	.012

CONTRA COSTA COUNTY
EMISSIONS OF TCE



Emissions(tons/year)
- ● = 1.2 - 1.4
- ● = 0.87 - 1.2
- ● = 0.58 - 0.87
- • = 0.29 - 0.58
- • = 0.0014 - 0.29

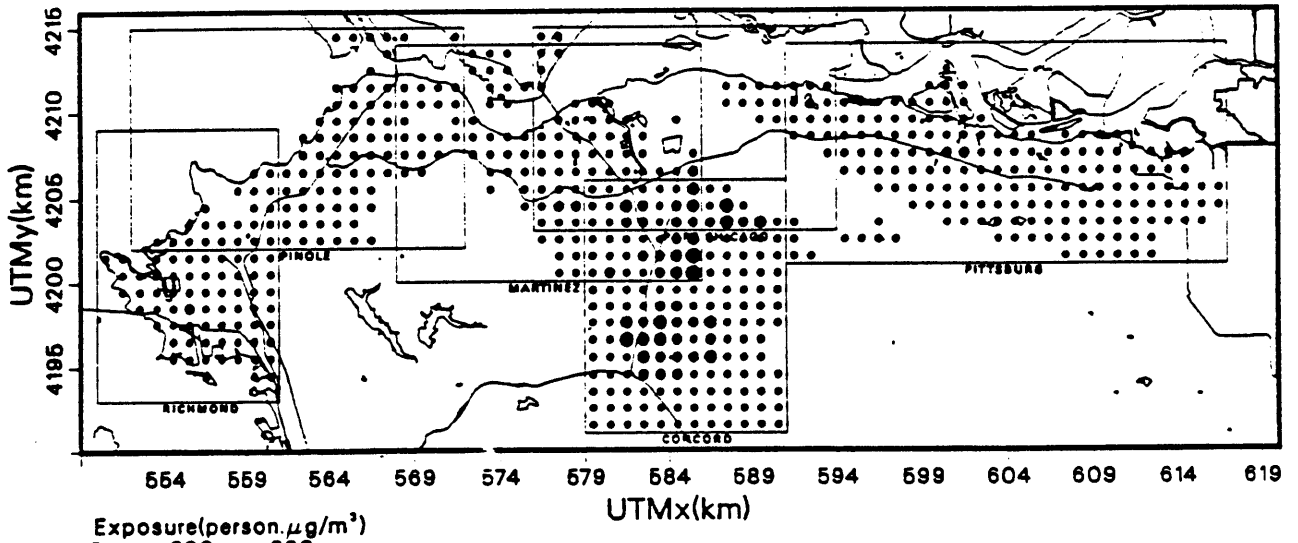
CONTRA COSTA COUNTY
CONCENTRATION OF TCE



Concentration($\mu g/m^3$)
● = 0.19 - 0.24
● = 0.14 - 0.19
● = 0.096 - 0.14
• = 0.048 - 0.096
• = 0.0002 - 0.048

Study Region Average Concentration = 0.017 ug/m3

CONTRA COSTA COUNTY
EXPOSURE TO TCE



Exposure(person.$\mu g/m^3$)
● = 300. - 380.
● = 230. - 300.
● = 150. - 230.
• = 75. - 150.
• = 0.38 - 75.

Aggregate Exposure = 14.850 person-ug/m3

EMISSIONS INVENTORY SUMMARY
VINYL CHLORIDE

COUNTY	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Contra Costa	0.	0.	0.	0.
Solano	0.	0.	0.	0.

TOTAL EMISSIONS BY GENERAL SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (TPY)

CATEGORY DESCRIPTION	TPY VNCL	PERCENT OF TOTAL

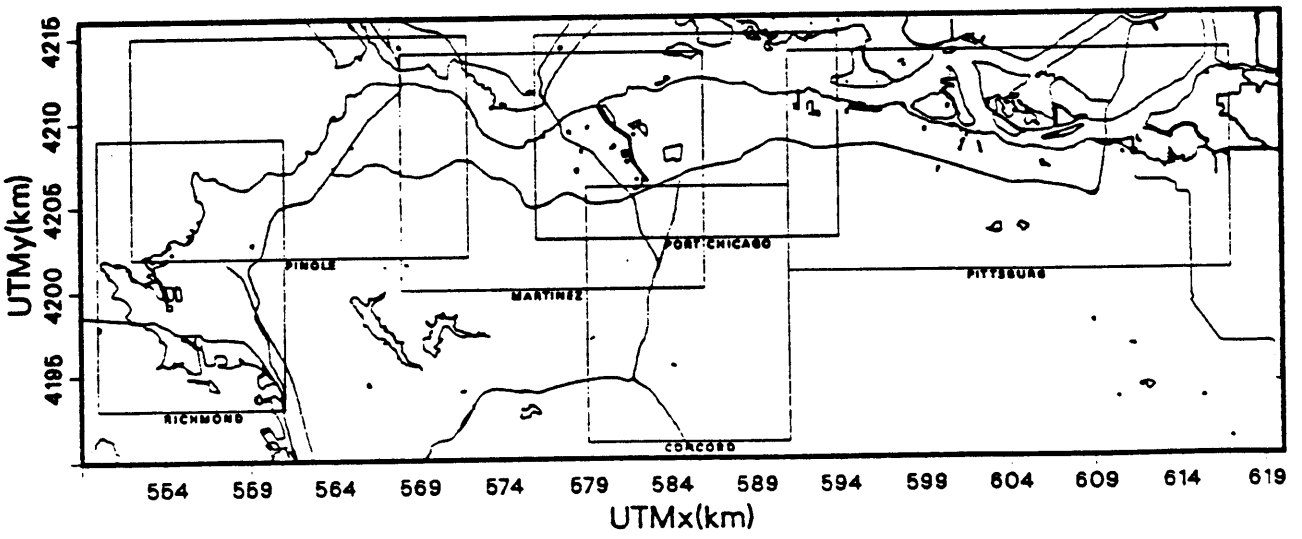
NO POINT, AREA, OR MOBILE SOURCES OF VINYL CHLORIDE WERE IDENTIFIED.

POINT SOURCE INVENTORY FACILITY LISTING

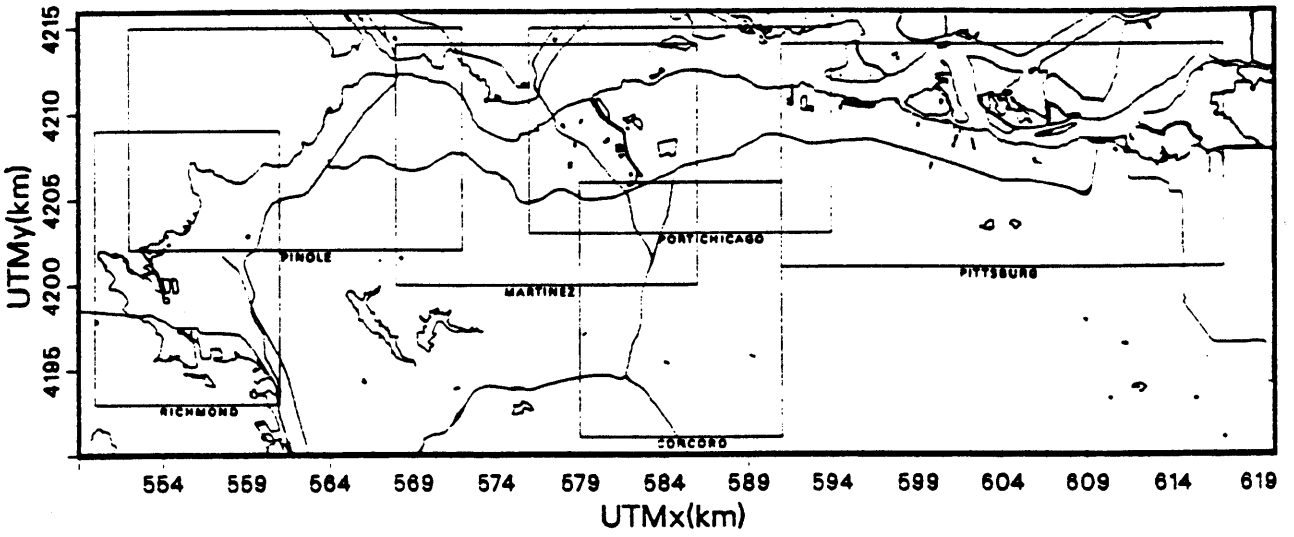
P#	PLANT NAME	CITY	TPY VNCL

NO POINT SOURCES OF VINYL CHLORIDE WERE IDENTIFIED.

CONTRA COSTA COUNTY
EMISSIONS OF VINYL CHLORIDE

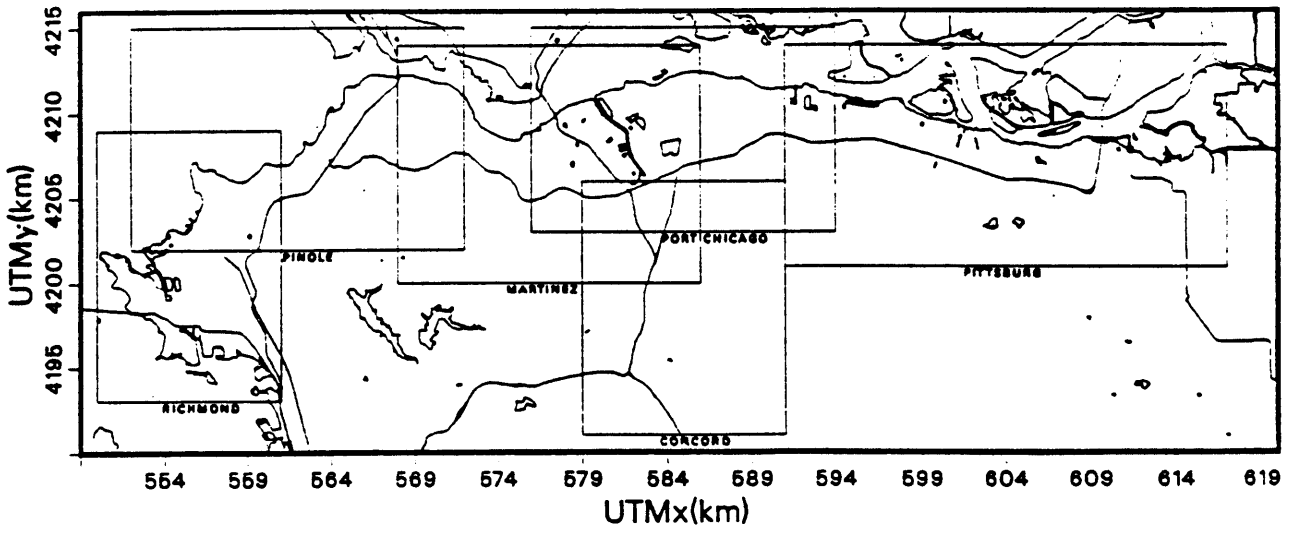


CONTRA COSTA COUNTY
CONCENTRATION OF VINYL CHLORIDE



Study Region Average Concentration = 0 ug/m3

CONTRA COSTA COUNTY
EXPOSURE TO VINYL CHLORIDE



Aggregate Exposure = 0 person-ug/m3

EMISSIONS INVENTORY SUMMARY
ARSENIC

COUNTY	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Contra Costa	0.092	0.004	0.	0.096
Solano	0.	0.001	0.	0.001

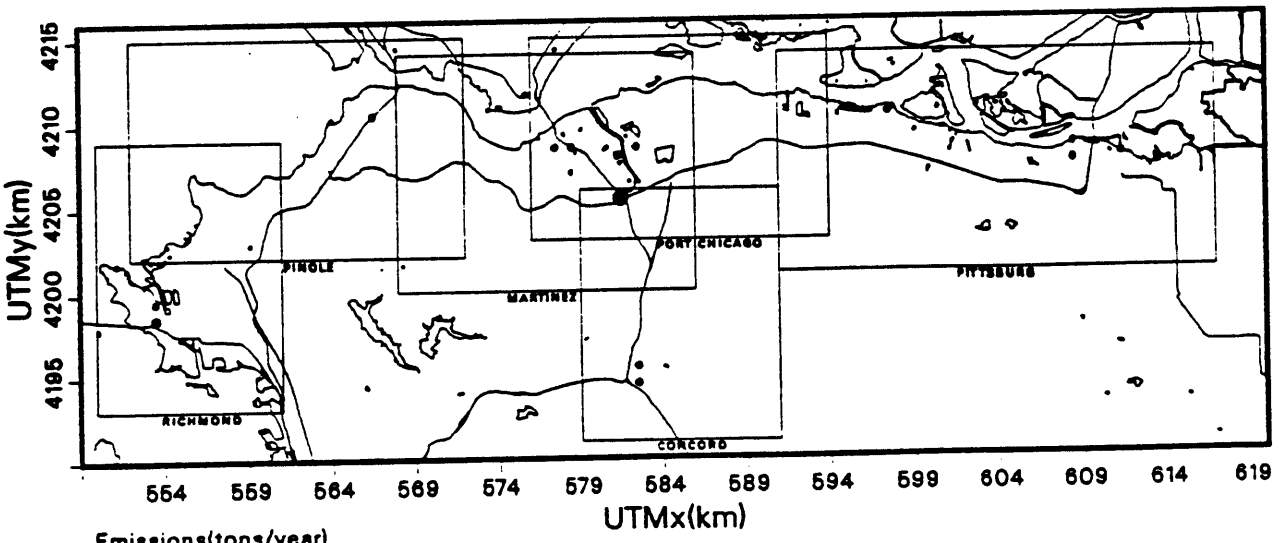
TOTAL EMISSIONS BY GENERAL SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (TPY)

CATEGORY DESCRIPTION	TPY ARSN	PERCENT OF TOTAL
STATIONARY FUEL COMBUSTION	.096	100.00

POINT SOURCE INVENTORY FACILITY LISTING (TOP 10)

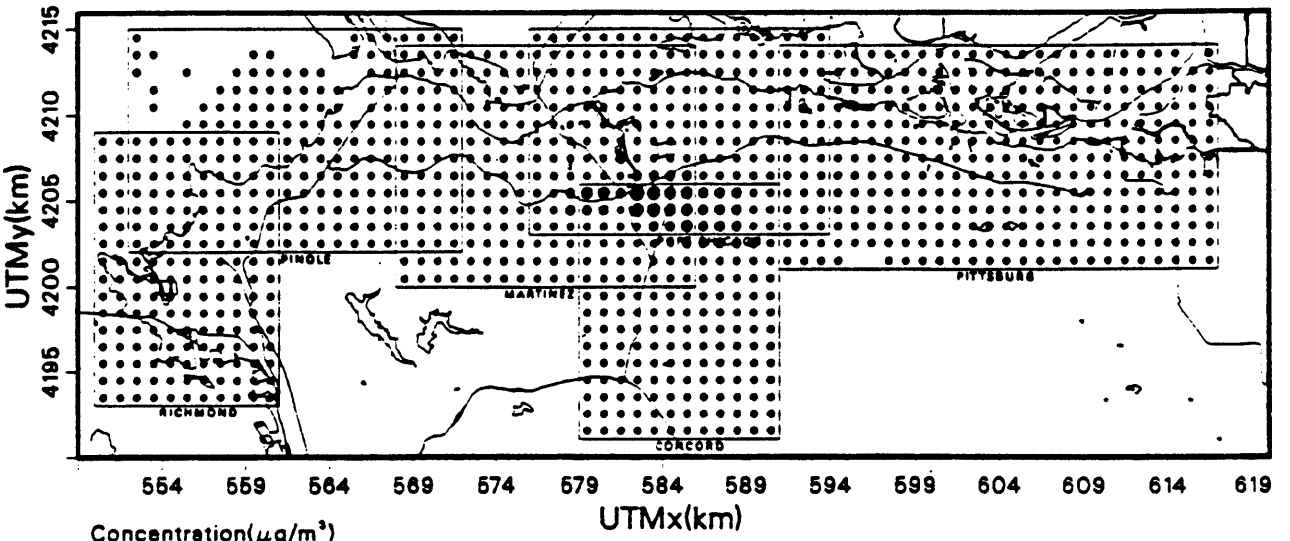
P#	PLANT NAME	CITY	TPY ARSN
907	Central Contra Costa Sanitary District	Martinez	.059
10	Chevron USA, Inc	Richmond	.020
11	Shell Oil Company	Martinez	.003
12	Pacific Gas & Electric Company	Pittsburg	.003
16	Union Oil Company	Rodeo	.002
18	Pacific Gas and Electric Company	Antioch	.002
19	Louisiana-Pacific Corporation	Antioch	.002
13	Tosco Corp, Avon Refinery	Martinez	.001
606	Anheuser-Busch, Inc	Fairfield	<.001
44	Mare Island Naval Shipyard	Vallejo	<.001

CONTRA COSTA COUNTY
EMISSIONS OF INORGANIC ARSENIC



Emissions(tons/year)
- ● = 0.048 - 0.060
- ● = 0.036 - 0.048
- ● = 0.024 - 0.036
- ● = 0.012 - 0.024
- • = 0.00006 - 0.012

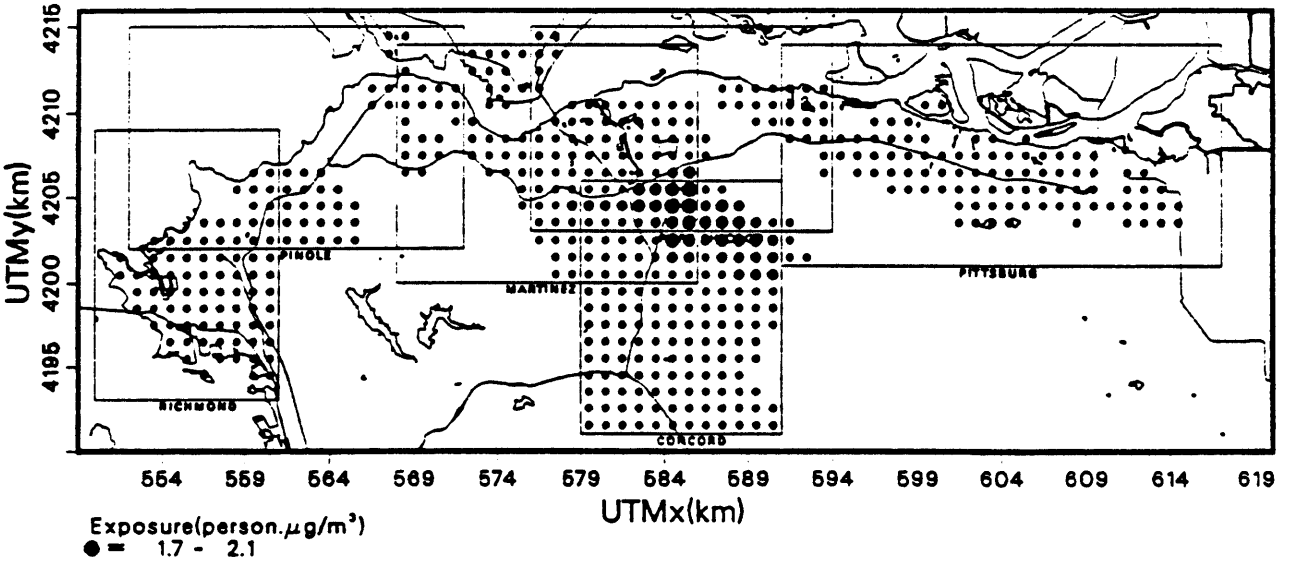
CONTRA COSTA COUNTY
CONCENTRATION OF INORGANIC ARSENIC



Concentration($\mu g/m^3$)
- ● = 0.0014 - 0.0018
- ● = 0.0011 - 0.0014
- ● = 0.00072 - 0.0011
- • = 0.00036 - 0.00072
- • = 0.000002 - 0.00036

Study Region Average Concentration = 0.000067 ug/m3

CONTRA COSTA COUNTY
EXPOSURE TO INORGANIC ARSENIC



Exposure(person.$\mu g/m^3$)
- ● = 1.7 - 2.1
- ● = 1.3 - 1.7
- ● = 0.84 - 1.3
- • = 0.42 - 0.84
- • = 0.0021 - 0.42

Aggregate Exposure = 65 person-ug/m3

EMISSIONS INVENTORY SUMMARY
CADMIUM

COUNTY	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Contra Costa	0.035	0.083	0.137	0.255
Solano	0.	0.084	0.064	0.148

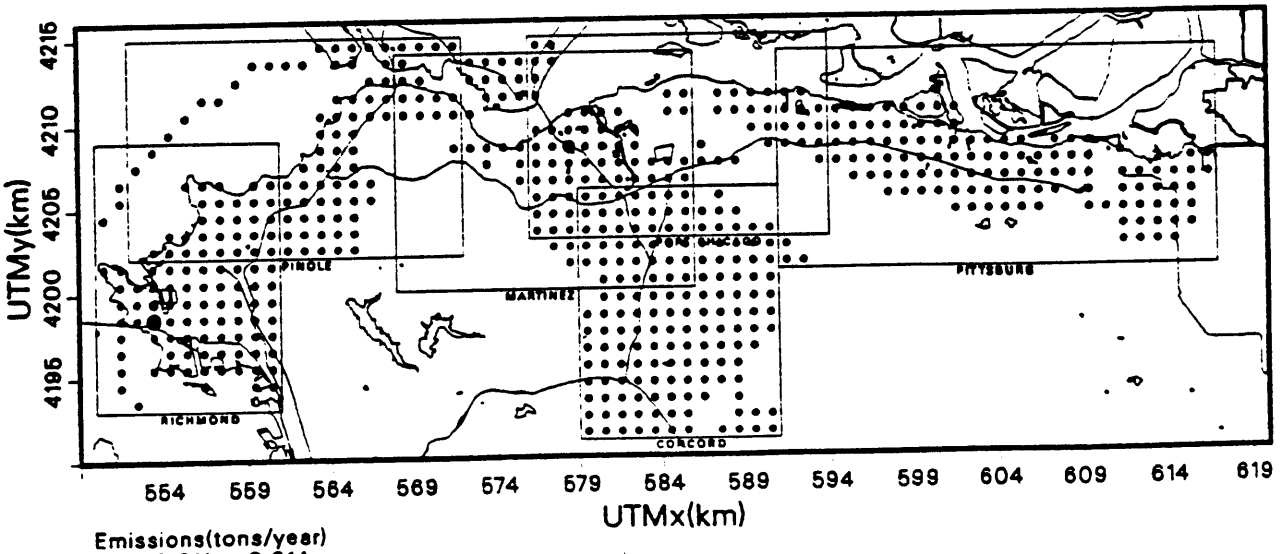
TOTAL EMISSIONS BY GENERAL SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (TPY)

CATEGORY DESCRIPTION	TPY CADM	PERCENT OF TOTAL
ON-ROAD MOBILE SOURCES	.137	53.61
STATIONARY FUEL COMBUSTION	.073	28.64
OFF-ROAD MOBILE SOURCES	.026	10.37
BURNING OF WASTE MATERIAL	.019	7.26
AIRCRAFT	<.001	.12

POINT SOURCE INVENTORY FACILITY LISTING (TOP 10)

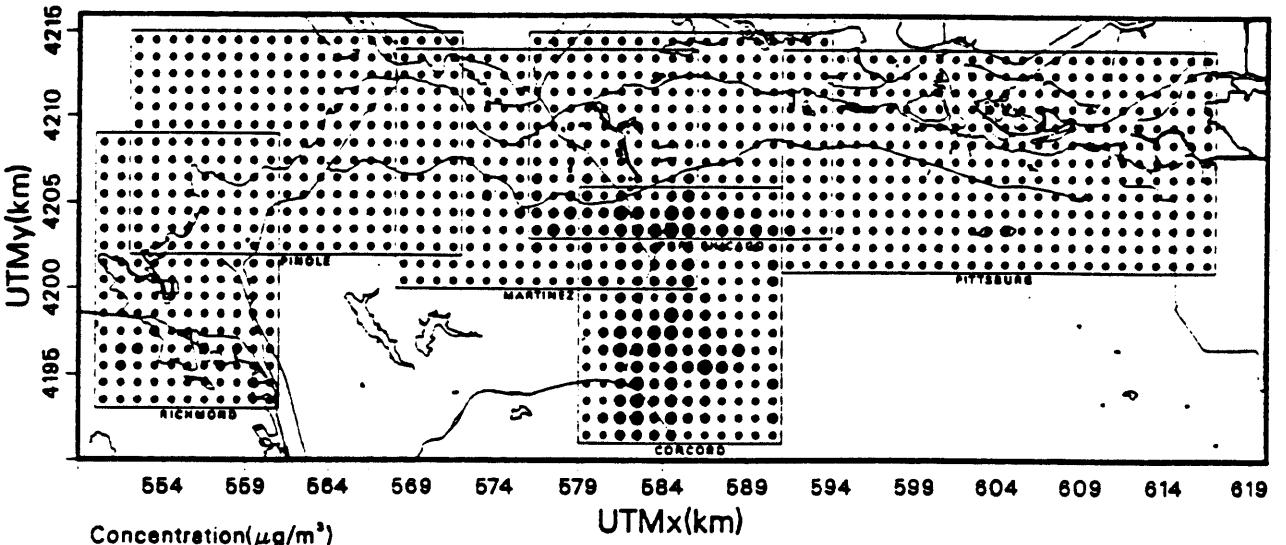
P#	PLANT NAME	CITY	TPY CADM
10	Chevron USA, Inc	Richmond	.0169
11	Shell Oil Company	Martinez	.0079
907	Central Contra Costa Sanitary District	Martinez	.0026
12	Pacific Gas & Electric Company	Pittsburg	.0024
16	Union Oil Company	Rodeo	.0017
18	Pacific Gas and Electric Company	Antioch	.0015
19	Louisiana-Pacific Corporation	Antioch	.0014
13	Tosco Corp, Avon Refinery	Martinez	.0005
606	Anheuser-Busch, Inc	Fairfield	.0002
44	Mare Island Naval Shipyard	Vallejo	<.0001

CONTRA COSTA COUNTY
EMISSIONS OF CADMIUM



Emissions(tons/year)
- ● = 0.011 - 0.014
- ● = 0.0086 - 0.011
- ● = 0.0057 - 0.0086
- ● = 0.0029 - 0.0057
- • = 0.00001 - 0.0029

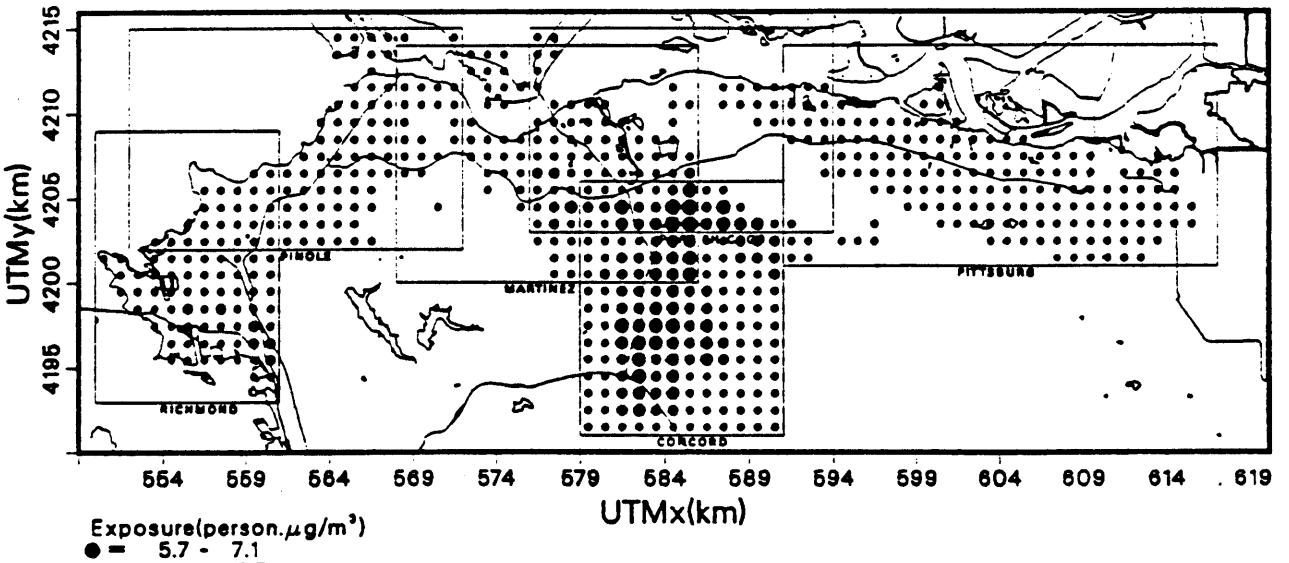
CONTRA COSTA COUNTY
CONCENTRATION OF CADMIUM



Concentration($\mu g/m^3$)
- = 0.0040 - 0.0049
- = 0.0030 - 0.0040
- = 0.0020 - 0.0030
- = 0.00099 - 0.0020
- = 0.000005 - 0.00099

Study Region Average Concentration = 0.0004 ug/m3

CONTRA COSTA COUNTY
EXPOSURE TO CADMIUM



Exposure(person.$\mu g/m^3$)
- = 5.7 - 7.1
- = 4.3 - 5.7
- = 2.8 - 4.3
- = 1.4 - 2.8
- = 0.0071 - 1.4

Aggregate Exposure = 399 person-ug/m3

EMISSIONS INVENTORY SUMMARY
CHROMIUM

COUNTY	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Contra Costa	0.017	0.602	0.992	1.611
Solano	0.002	0.183	0.479	0.664

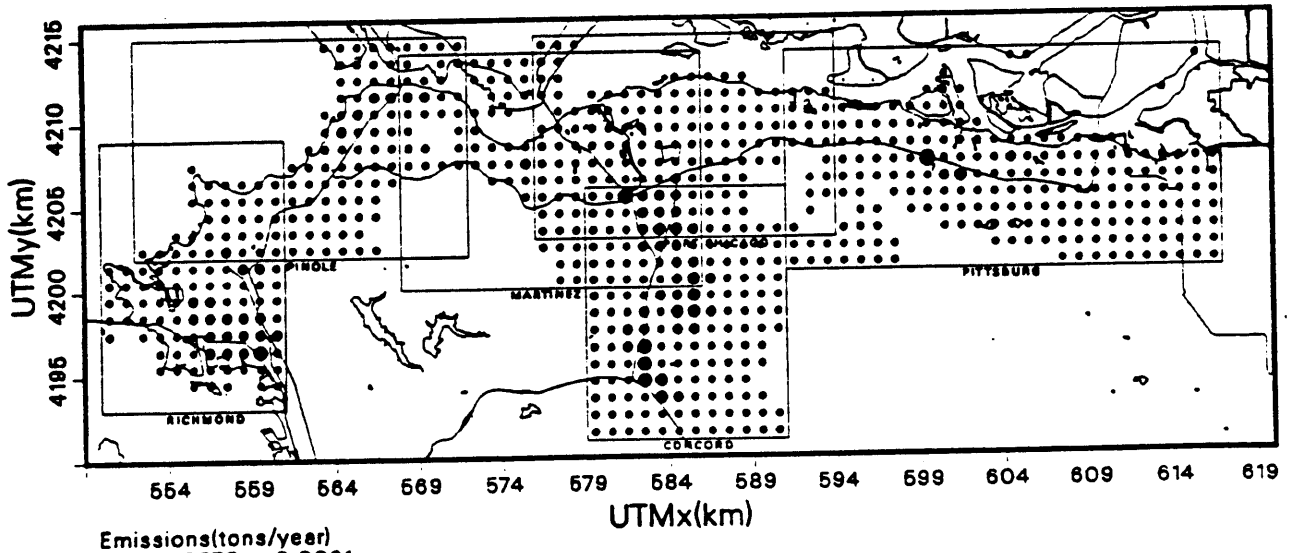
TOTAL EMISSIONS BY GENERAL SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (TPY)

CATEGORY DESCRIPTION	TPY CHRM	PERCENT OF TOTAL
ON-ROAD MOBILE SOURCES	.992	61.61
STATIONARY FUEL COMBUSTION	.331	20.54
OFF-ROAD MOBILE SOURCES	.171	10.60
MISCELLANEOUS EMISSION SOURCES	.097	6.04
BURNING OF WASTE MATERIAL	.011	.67
CHROME PLATING	.009	.55

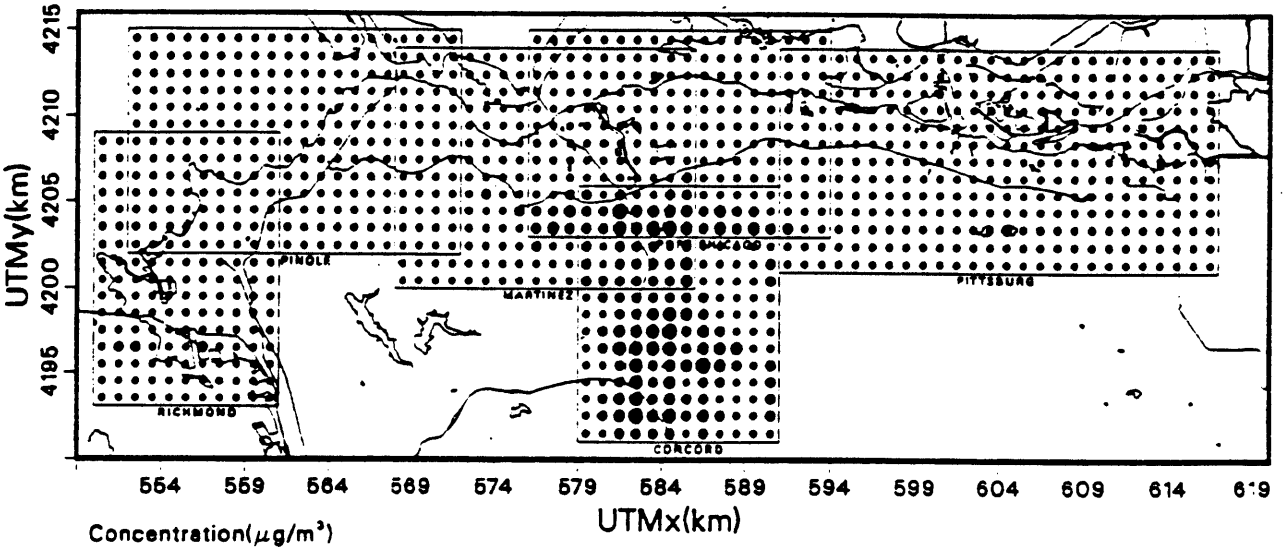
POINT SOURCE INVENTORY FACILITY LISTING (TOP 10)

P#	PLANT NAME	CITY	TPY CHRM
907	Central Contra Costa Sanitary District	Martinez	.0082
2371	USS-POSCO Industries	Pittsburg	.0069
9005	Pacific Hard Chrome	Richmond	.0019
44	Mare Island Naval Shipyard	Vallejo	.0015
11	Shell Oil Company	Martinez	.0002
10	Chevron USA, Inc	Richmond	.0002
9006	Electro Forming Company	Richmond	<.0001
12	Pacific Gas & Electric Company	Pittsburg	<.0001
16	Union Oil Company	Rodeo	<.0001
18	Pacific Gas and Electric Company	Antioch	<.0001

CONTRA COSTA COUNTY
EMISSIONS OF CHROMIUM



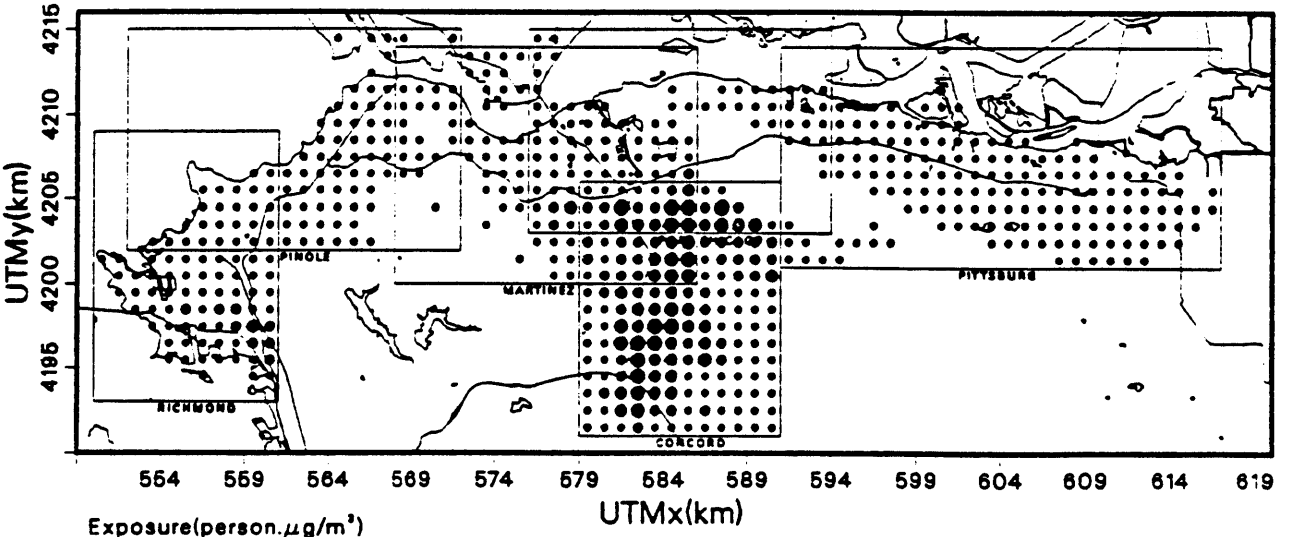
CONTRA COSTA COUNTY
CONCENTRATION OF CHROMIUM



Concentration($\mu g/m^3$)
- ● = 0.024 - 0.030
- ● = 0.018 - 0.024
- ● = 0.012 - 0.018
- • = 0.0061 - 0.012
- • = 0.00003 - 0.0061

Study Region Average Concentration = 0.0025 ug/m3

CONTRA COSTA COUNTY
EXPOSURE TO CHROMIUM



Exposure(person.$\mu g/m^3$)
- ● = 29. - 36.
- ● = 22. - 29.
- ● = 15. - 22.
- • = 7.3 - 15.
- • = 0.036 - 7.3

Aggregate Exposure = 2,507 person-ug/m3

EMISSIONS INVENTORY SUMMARY
POLYCYCLIC AROMATIC HYDROCARBONS

COUNTY	EMISSIONS (TONS PER YEAR) POINT	AREA	MOBILE	TOTAL
Contra Costa	0.12	7.27	5.08	12.47
Solano	0.	2.70	2.36	5.06

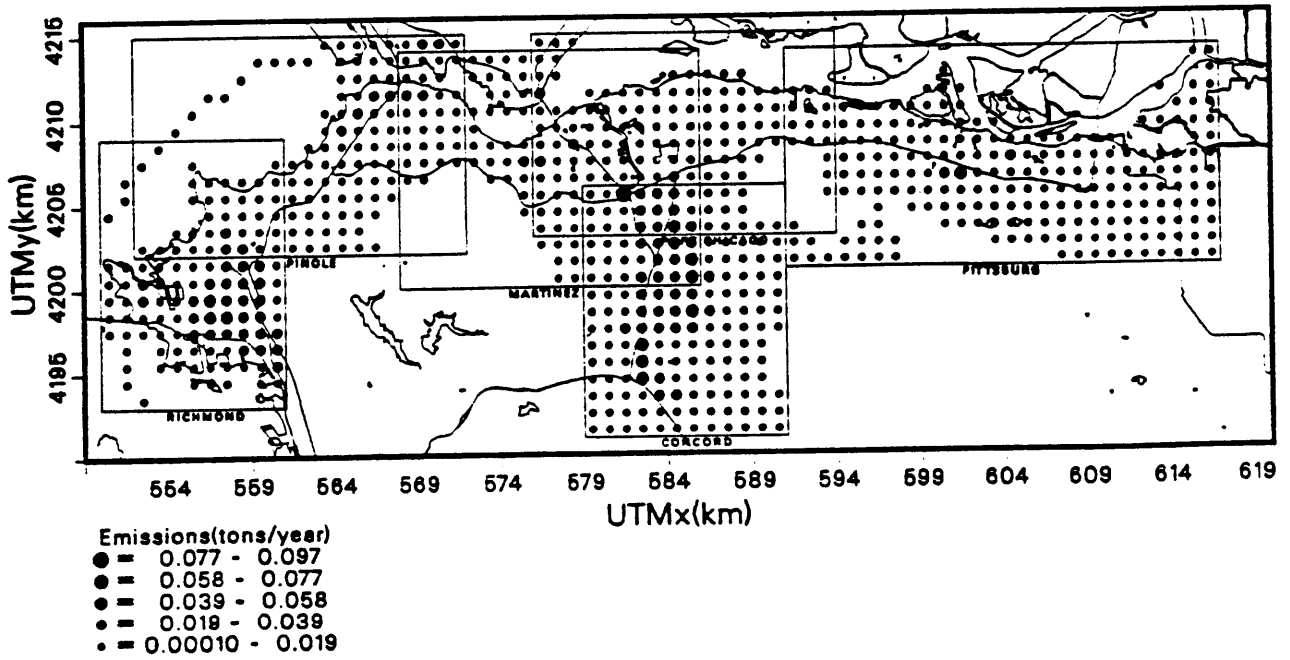
TOTAL EMISSIONS BY GENERAL SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (TPY)

CATEGORY DESCRIPTION	TPY PAH	PERCENT OF TOTAL
STATIONARY FUEL COMBUSTION	5.355	42.95
ON-ROAD MOBILE SOURCES	5.077	40.72
OFF-ROAD MOBILE SOURCES	1.590	12.75
BURNING OF WASTE MATERIAL	.340	2.73
AIRCRAFT	.057	.45
MISCELLANEOUS EMISSION SOURCES	.049	.39

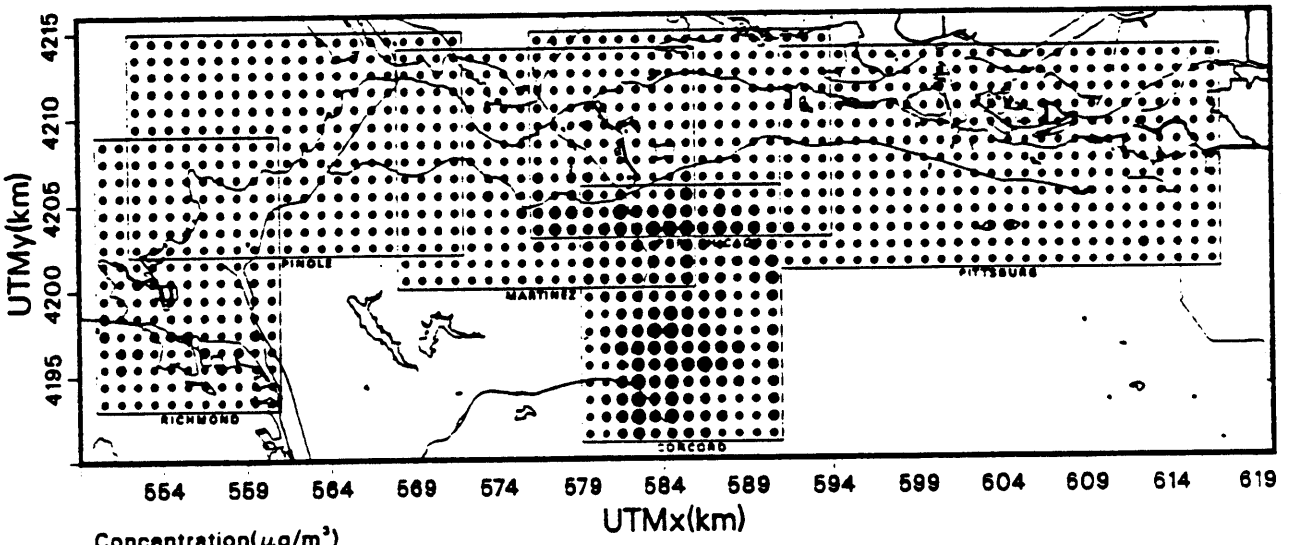
POINT SOURCE INVENTORY FACILITY LISTING (TOP 10)

P#	PLANT NAME	CITY	TPY PAH
907	Central Contra Costa Sanitary District	Martinez	.0883
11	Shell Oil Company	Martinez	.0169
10	Chevron USA, Inc	Richmond	.0091
12	Pacific Gas & Electric Company	Pittsburg	.0013
16	Union Oil Company	Rodeo	.0009
18	Pacific Gas and Electric Company	Antioch	.0008
19	Louisiana-Pacific Corporation	Antioch	.0007
13	Tosco Corp, Avon Refinery	Martinez	.0003
219	Naval Weapons Station	Concord	.0002
2823	Independent Renderers	Richmond	.0001

CONTRA COSTA COUNTY
EMISSIONS OF PAH



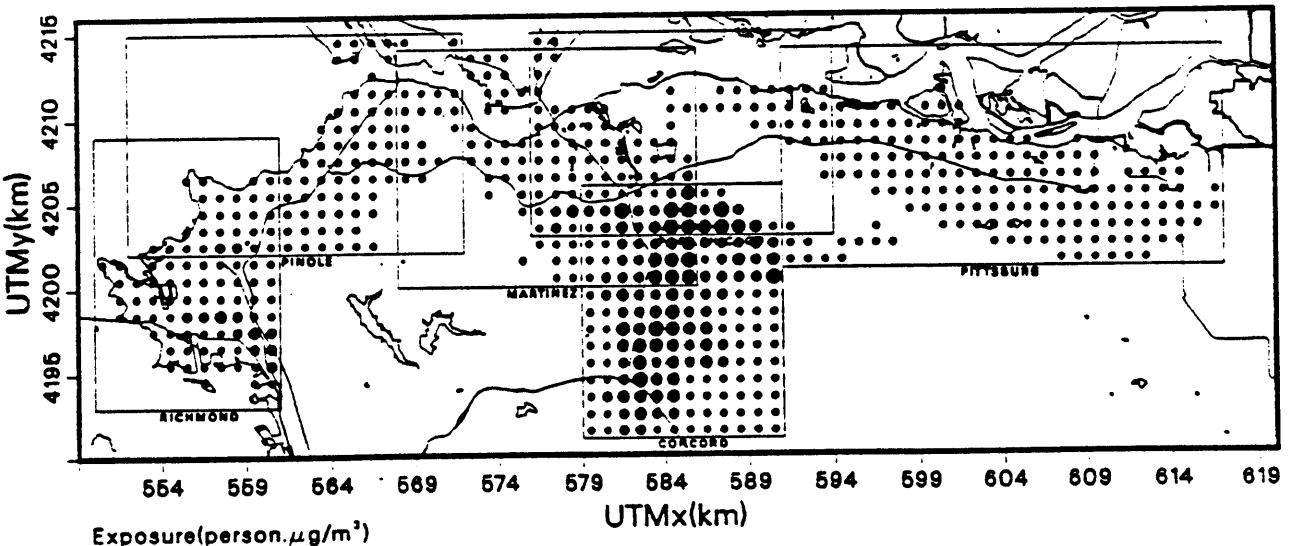
CONTRA COSTA COUNTY
CONCENTRATION OF PAH



Concentration($\mu g/m^3$)
- ● = 0.23 - 0.29
- ● = 0.18 - 0.23
- ● = 0.12 - 0.18
- • = 0.059 - 0.12
- • = 0.0003 - 0.059

Study Region Average Concentration = 0.029 ug/m3

CONTRA COSTA COUNTY
EXPOSURE TO PAH



Exposure(person.$\mu g/m^3$)
- ● = 360. - 450.
- ● = 270. - 360.
- ● = 180. - 270.
- • = 89. - 180.
- • = 0.45 - 89.

Aggregate Exposure = 30,331 person-ug/m3

IV.3 DISCUSSION OF RESULTS

The four TACs with the highest average concentrations over the entire study region were the same TACs that had the highest total emissions: methylene chloride (MC), formaldehyde, benzene and perchloroethylene (PCE). These were the only pollutants in the study region with predicted concentrations averaging greater than 1 ug/m3. These pollutants also had aggregate exposures that were more than twice as high as any of the other TACs. Each of the high-emission TACs (which are all organic gases), has the bulk of its emissions in area source and/or mobile source categories. The spatial patterns of emissions and concentrations for these pollutants generally follow population and/or traffic patterns.

The TACs with the highest maximum predicted concentrations (within a grid cell) were, in order: MC, PCE, carbon tetrachloride, benzene, formaldehyde and phenol. Of the sixteen TACs included in the study, these were the only pollutants with maximum annual average concentrations greater than 1 ug/m3. These TACs also had the highest maximum predicted exposures (within a grid cell) of the pollutants studied, with maximum exposures ranging from about 6000 to 60,000 person-ug/m3 for a 1-kilometer grid cell. The maximum exposures for all the other TACs studied were less than 500 person-ug/m3 for any grid cell.

The highest concentrations of MC, PCE and carbon tetrachloride resulted primarily from low-level, non-buoyant, fugitive emissions at chemical plants. Larger dry cleaning plants treated as point sources also resulted in elevated PCE levels. The modeling indicates that the elevated concentrations from these types of sources are quite localized, decreasing rapidly with distance from the point of emission. It may be that elevated exposures from these sources are calculated because the population file used in the study lacks adequate resolution. Population is spread out uniformly within a census tract, even to portions of the tract which may have no residential population. Thus, localities near a source may show high exposures when, in actuality, no one lives near the source, and the human exposure is negligible.

Maximum benzene and formaldehyde exposures were calculated in the Concord subarea, a high density population area with an abundance of mobile source activity. Within this subarea, concentration patterns of these TACs largely followed traffic patterns, with elevated levels predicted to occur along the eastern side of Highway 680 from Walnut Creek to Concord.

Phenol concentrations and exposures generally followed household distribution patterns due to fireplace emissions.

Although sixty percent of the total phenol emissions were from a single point source in Antioch, elevated concentrations in this area were not predicted. This is because the emissions from this source are buoyant and are released from a tall stack, so that substantial plume rise and effective dispersion reduce concentrations.

Of the gaseous organic TACs, (other than vinyl chloride) ethylene dibromide had the lowest predicted concentrations and exposures. The highest concentrations of ethylene dibromide were predicted to occur near the Buchanan Field airport because of the use of leaded aviation fuel. But the calculated levels are below the limits of detection of existing monitoring methods (0.08 to 0.16 ug/m3).

Of the TACs emitted in particulate matter form, the exposures were predicted to be highest for the PAHs. The spatial patterns of PAH concentrations largely follow mobile source activity and household distribution patterns. Of the metals studied, chromium concentrations were predicted to be the highest. Chromium concentrations largely followed mobile source activity patterns because emissions are largely from diesel trucks.

IV. 4 COMPARISON OF MODELING RESULTS WITH MONITORING DATA

There was not enough information available to allow a rigorous performance evaluation of the modeling completed for this exposure study. The realism of maximum model predictions was assessed by comparing maximum predicted concentrations with maximum observed concentrations at the air toxics monitoring stations located in the Bay Area. The locations of BAAQMD and CARB-operated air toxics monitoring stations in the Bay Area are shown in Figure IV-1.

A comparison of maximum modeled concentrations with maximum observed concentrations for two different years is given in Table IV-1 for the eleven TACs included in this study for which ambient monitoring data is available. For comparisons with ambient data, the maximum predicted concentrations are combined in the second column of the table with the annual average background concentrations collected at the remote Fort Cronkite monitoring site. The third column in the table contains the maximum measured annual average TAC concentrations for all BAAQMD operated monitoring sites for the year 1987. The fourth column contains the highest measured annual average TAC concentrations for all CARB operated monitoring sites in the Bay Area for the year 1985. The CARB network includes two monitors located in Contra Costa County.

Table IV shows that the maximum predicted concentrations plus background levels are within a factor of two of the maximum observed concentrations (for either CARB or BAAQMD

data sets) for all TACs except carbon tetrachloride, MC and chromium, which were all overpredicted. The highest predicted carbon tetrachloride and MC concentrations were found to be in the immediate vicinity of two chemical plants in Contra Costa County. If these localized elevated impacts were not considered, the highest concentrations of MC and carbon tetrachloride would also be within a factor of two of the maximum observed concentrations. No obvious explanations exist for the differences in predicted and observed chromium concentrations, although errors in mobile source inventory estimates are suspected.

Although the ambient monitoring network does not directly measure 1,4-dioxane, the ambient concentrations of this TAC can be estimated from 1,1,1-trichloroethane (TCA) levels (the primary use of 1,4-dioxane is as a stabilizer in TCA solvent). The maximum annual average ambient TCA concentration for the CARB and BAAQMD data sets was 22.7 ug/m3. Using the average percentage of 1,4-dioxane in TCA from inventory estimates (1.31 percent, by weight), the maximum ambient 1,4-dioxane concentration is calculated to be 0.29 ug/m3. The maximum predicted 1,4-dioxane concentration (including calculated background estimates) is 0.20 ug/m3, which agrees favorably with the value calculated from observed TCA levels.

Long-term PAH monitoring performed at three sites in Contra Costa County during the period 1979 to 1986 (Flessel et al., 1987) provides a data base for the comparison of maximum predicted and observed PAH levels. Because direct comparisons of total PAH concentrations are not possible, benzo(a)pyrene (BaP) was used as a surrogate for comparing predicted and observed PAH concentrations. The maximum predicted BaP concentration was calculated from the maximum predicted total PAH concentration (0.29 ug/m3) by assuming that BaP is a fixed percentage (0.67 percent) of total PAH emissions based on mobile source inventory estimates. (The bulk of PAH emissions are from mobile sources.) The maximum calculated BaP concentration (0.0019 ug/m3) compares favorably with the maximum observed BaP concentration (0.0025 ug/m3, annual average). The PAH ambient monitoring data are also in agreement with the predictions of this study regarding the location of maximum PAH levels in Contra Costa County (i.e. in the Concord area).

As the modeling analysis predicted, ambient monitoring data also suggest that sources with low-level, non-buoyant, TAC emissions may result in localized elevated concentrations. Annual average PCE concentrations in 1987 were observed to be about ten times higher at one site than at any other monitoring site in the Bay Area. These elevated concentrations were attributed to PCE emissions from a nearby dry cleaning shop (Levaggi, et al., 1988).

TABLE IV-1

COMPARISON OF MODELING RESULTS WITH MONITORING DATA

TAC	Max. Modeled Concentration (1)	Max. Modeled Conc. plus Bkgrd Conc. (2)	1987 BAAQMD Max. Measured Concentration (3)	1985 CARB Max. Measured Concentration (4)
ORGANIC GASES (micrograms/cubic meter)				
Benzene	12.0	13.3	6.8	10.5
Carbon Tetrachloride	23.0	23.7	.70	1.3
Chloroform	.79	.89	.64	.24
Methylene Chloride	39.0	42.2	9.2	15.2
Ethylene Dibromide	.01	.01	< LOD	.10
Perchloro-ethylene	37.0	37.4	27.5	5.3
Trichloro-ethylene	.24	.57	1.1	4.0
Vinyl chloride	0	< LOD	< LOD	ND
METALS (nanograms/cubic meter)				
Arsenic	1.8	ND	ND	2.1
Cadmium	4.9	ND	ND	4.3
Chromium	30.0	ND	ND	7.6

ND - no data available.
< LOD - compound never measured at or above limit of detection.

(1) The maximum modeled concentration is the highest predicted annual average concentration for all 1-kilometer receptor grids.

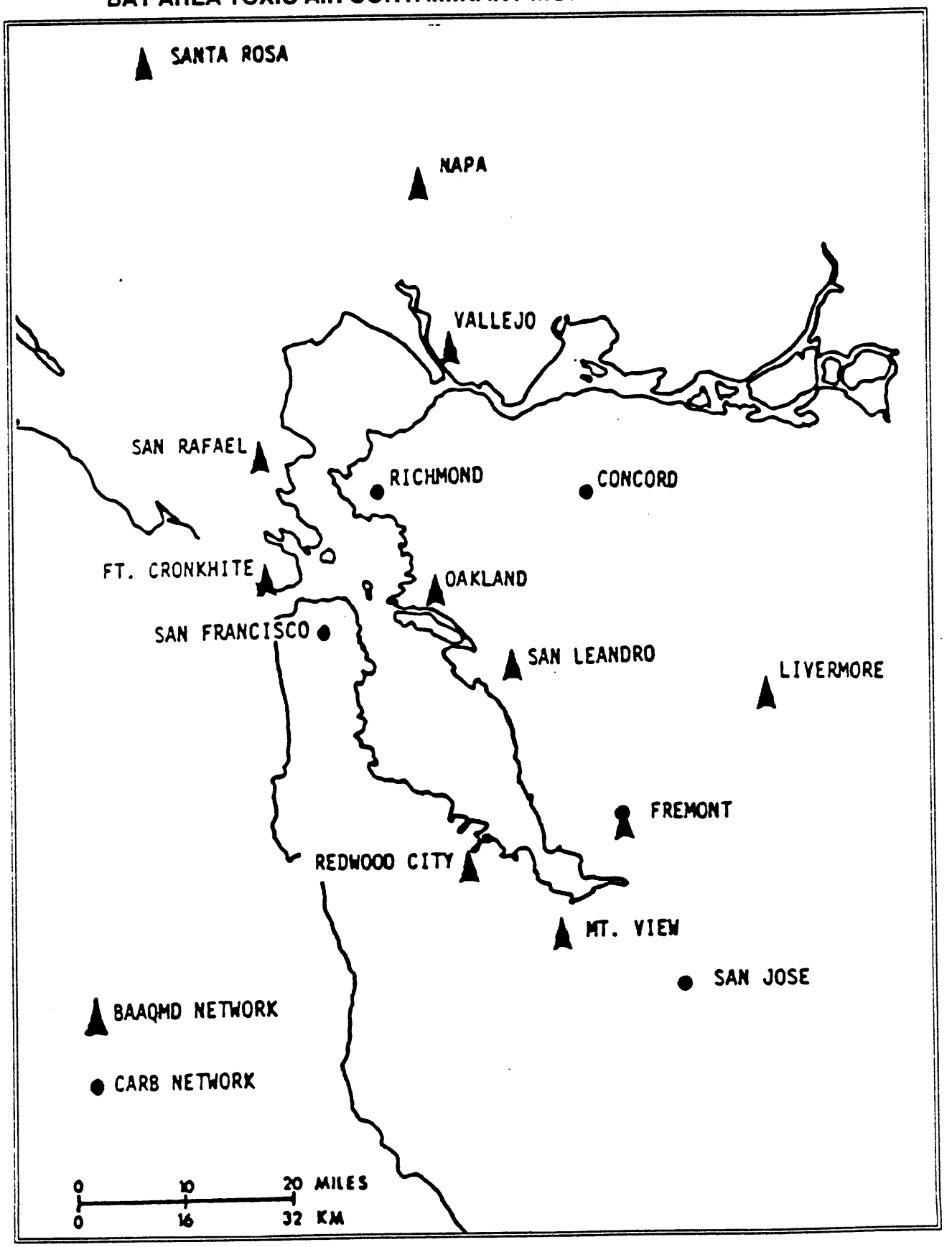
(2) The maximum modeled concentration plus background is the sum of the highest predicted concentration and the 1987 BAAQMD annual mean monitored concentration at the Fort Cronkite background station.

(3) The 1987 BAAQMD maximum measured concentration is the highest annual mean concentration for all BAAQMD operated toxic monitoring stations for the year 1987.

(4) The 1985 CARB maximum measured concentration is the highest annual mean concentration for all CARB operated toxic monitoring stations located in the Bay Area for the year 1985.

FIGURE IV-1

BAY AREA TOXIC AIR CONTAMINANT MONITORING NETWORK



V. RECOMMENDATIONS

In this study, air quality dispersion modeling was used to estimate exposure to selected TACs in Contra Costa County, a highly populated urban area with a substantial amount of heavy industry. The study was designed to (1) help site additional ambient TAC monitors and, (2) direct subsequent, more refined, investigations to be used in developing TAC control programs. The following sections contain recommendations for carrying out these ensuing projects based on the results of the modeling study.

V.1 RECOMMENDATIONS FOR SITING ADDITIONAL TAC MONITORS

The existing air toxics monitoring network in the Bay Area includes stations in the Cities of Richmond and Concord in Contra Costa County. The BAAQMD is planning on expanding the ambient monitoring network by establishing three additional monitoring sites in the County. Based on the results of this dispersion modeling study, BAAQMD staff has proposed the following locations for monitoring:

PROPOSED AIR TOXICS MONITORING LOCATIONS

(1)	Walnut Creek, near the intersection of Highways 24 and 680.
(2)	West Antioch, east of the Dow Chemical plant.
(3)	Martinez, between the Shell and Tosco refineries.
(4)	Hercules or Rodeo, between the Union and Pacific refineries.

The Walnut Creek location was selected primarily because of its heavy motor vehicle activity and frequently congested traffic conditions. This area was predicted to have higher-than-average concentrations of motor vehicle related TACs (e.g. benzene). In addition, pollutant exposures were predicted to be relatively high because the area is densely populated.

The other monitoring locations were selected primarily because of their proximity to sources with low-level, non-buoyant, emissions of organic TACs. The modeling study indicates that these types of sources can result in elevated TAC concentrations near their point of release, although these impacts are predicted to decrease rather rapidly with distance downwind.

These monitors will help determine if annual TAC exposures near these types of sources are significantly greater than at other, more distant locations. It is recommended that the monitors be located relatively close to where the

emissions occur, but in areas where residential exposure nonetheless occurs. Monitoring is expected to occur at two of the three locations listed; three sites were identified because administrative and/or logistical constraints may eliminate one of the areas.

The TACs of most interest at the West Antioch site are carbon tetrachloride, methylene chloride, and perchloroethylene emitted from low-level sources at the nearby chemical plant. The other two prospective monitoring sites are near refineries, which have low-level sources of VOCs. Benzene is expected to be the most significant.

V.2 RECOMMENDATIONS FOR FUTURE AIR TOXICS INVESTIGATIONS

This modeling study provided estimates of exposure to selected TACs in Contra Costa County, and revealed preliminary source/receptor relationships. A number of recommendations for refining the exposure analysis and reducing uncertainty in the results are given in this section.

REFINING THE EMISSIONS INVENTORY

Many elements of the inventory compiled for this study could be improved through further investigations. The air toxics inventory should be maintained and upgraded on a routine basis for both permitted and non-permitted sources of selected TACs. Some specific areas where the air toxics emissions inventory could be improved are given below:

(1) Perform Focused Emissions Investigations for the More Important Point Source Facilities

In this study, generalized information in the literature was heavily relied upon in an effort to compile a comprehensive inventory. Such emissions estimates may be generally applicable, but may not accurately reflect the source configuration, control equipment, or operating practices of specific sources. Future inventory efforts should use more specific emission estimates resulting from focused investigations of individual facilities where possible.

In this regard, one conspicuous need is to refine the estimates of fugitive organic TAC emissions from chemical plants. Generalized emission estimates for chemical production facilities are not considered to be reliable. It is recommended that the fugitive emission estimates from chemical plants be refined using the Annual Toxic Chemical Release Reporting required by Title III of the Superfund Amendments and Reauthorization Act (SARA).

(2) Continue to Expand, Update and Broaden the List of Point Source Emission Factors/Species Fractions

Emission factors and species fractions for types of point sources that were not included in this study should be added to the data bank when reliable emissions information becomes available. Existing factors should also be reviewed periodically and updated when newer, more reliable emissions data becomes available. In particular, the point source factor used for phenol emissions from wood combustion (2 lb/ton) should be reviewed for possible updating.

Efforts should also be made to extend the range of factors in the data bank to cover a wider variety of sources. Such a broad range of factors covering many different source codes was used in this study to compile the point source formaldehyde inventory.

(3) Investigate Ways to Improve Area Source Emission Estimates

Emissions information for area sources was found to be the most difficult to obtain, and the lack of availability of reliable data limited the completeness of the inventory to some extent. In many cases, simplifying assumptions were used so that emission estimates could be made. These assumptions diminished the reliability of the results. Improvements in most area source categories could probably be made with further investigations. Specific areas where improvements could be made include:

(a) Pesticide use (benzene, carbon tetrachloride emissions).
(b) Pleasure boats (emission estimates were high due to high THC estimates).
(c) Consumer products (methylene chloride, formaldehyde, and perchloroethylene emissions).
(d) Paint stripping (methylene chloride emissions).
(e) Degreasing (TCE emissions - modeling underpredicted ambient levels).
(f) Fireplaces and wood stoves (wood usage estimates).

(4) Continue to Work to Include Emissions from Certain Non-traditional Source Types

Several types of sources were not included in this inventory due to inadequate emissions information. The emissions from some of these sources are currently being evaluated. The sources of TACs that need to be addressed in future exposure analyses include:

(a) Fugitive VOCs from refineries (e.g. benzene).

(b) Emissions of ethylene oxide from sterilizers and chromium from hard chrome platers (inventory estimates used in this study were incomplete).
(c) Cooling towers (chloroform emissions).
(d) Hazardous, industrial and municipal waste treatment and disposal facilities (e.g. vinyl chloride emissions from landfills).
(e) Emissions of metals in paved road dust and other fugitive dust sources.

(5) Improve Chromium and PAH Composition Profiles

Chromium can be emitted in several different oxidation states, including hexavalent chromium which is of the most interest as a TAC. Most available emissions data are, however, expressed in terms of total chromium. The composition profiles of chromium emissions from various types of sources need to be better defined.

The PAHs are a category of aromatic compounds, and PAH emissions data vary widely with respect to the specific compounds represented. The individual PAH compounds that are of primary concern as TACs need to be better evaluated, and the composition profiles of PAH emissions from different types of sources need to be better defined.

(6) Update Pollutant Coverage

It is believed that the pollutants covered in this study are responsible for the bulk of the total cancer risk that results from exposure to routinely released, outdoor TACs. In future studies, however, the list of TACs covered should be updated based on information regarding potential health risk and the availability of emissions data. Additional TACs recommended for future consideration are nickel, beryllium, butadiene and dibenzo-dioxins/furans.

(7) Incorporate Control Technology Changes

Inventory estimates for some TACs may change significantly from one year to another due to criteria pollutant control programs. For example, ethylene dibromide emissions have been decreasing substantially in recent years as the use of leaded gasoline decreases. Similarly, the emissions of benzene have been declining due to mobile source control programs aimed at reducing total hydrocarbons. If timely estimates of exposure to air toxics are desired, the emissions inventory must be routinely updated to reflect changes in control technology.

REFINING THE MODELING AND EXPOSURE ANALYSIS

This study used a rather simplified approach based on readily available information to estimate maximum annual average TAC concentrations and population exposure. A number of recommendations for modifying and refining this analysis are given below.

(1) Refining the Meteorological Data

Because adequate meteorological data were unavailable for the study region, it was necessary to make assumptions that may have resulted in significant errors in the modeling analysis. The following recommendations are made to obtain adequate meteorological inputs for future studies.

(a) Expand the meteorological tower network to include areas that are not adequately represented now. Currently, no data are available for the Concord and Walnut Creek area. This area is important because it contains a large population and has substantial motor vehicle-related TAC emissions.

(b) Determine whether siting, exposure, instrumentation and quality assurance are adequate to obtain reliable data at existing GLM sites. Some of the GLM meteorological instruments are located within industrial complexes, where nearby structures or terrain could perturb the wind flow. For such cases, wind data might not be representative of the wind field between the emissions and the receptor regions.

(c) Provide improved estimates of stability. For this study, stability was determined at each site by using on-site wind speed, together with cloud cover and ceiling height from the nearest reporting airport, either Travis Air Force Base or Oakland Airport. This method is, however, unreliable during certain meteorological conditions. With modern instrumentation, pollutant dispersion parameters can be measured directly using the observed variability of wind direction. The necessary calculations are normally made with a microcomputer attached to the meteorological tower.

(d) Obtain improved statistics on the inversion base height using Oakland Airport upper air data and, if available, measurements from tall towers, acoustic sounders and instrumented aircraft.

(2) Maintain and Improve Point Source Location Information

Information in the BAAQMD data bank regarding the UTM coordinates of plant centroids was used in the modeling completed for this study. This information is critical for modeling, and should be available for all plants that require permits. The UTM coordinates of new plants should be recorded at the time that permits are issued.

The existing data bank contains UTM coordinates only for those individual sources that have stacks. The modeling results would be improved if the UTM coordinates for all significant sources were recorded, particularly at plants that cover substantial areas.

(3) Obtain a More Detailed Population Data Base

In this study, exposure was estimated using a residential population file that assumed uniform population density for all grid cells within a given census tract. The use of a more refined population density file could significantly improve estimates of exposure. It may also be desirable to evaluate non-residential air toxics exposure patterns.

(4) Evaluate Temporal Emission Patterns in the Analysis

In this study, annual average concentration estimates were made assuming uniform emissions over time. Some types of sources, however, have significant diurnal or seasonal emission patterns (e.g. solvent evaporation and fireplace emissions, respectively). The exposure analysis could be refined by using seasonal- and diurnal- specific STAR tabulations for these types of sources.

(5) Maintain and Expand the Air Toxics Monitoring Network so that Model Performance Can be Better Evaluated

In order to adequately evaluate the performance of a regional modeling analysis, reliable ambient monitoring data must be available from a number of locations within the study area. Establishing the additional monitoring stations recommended in this report will substantially improve performance evaluation capabilities.

REFERENCES

Flessel, P., and Levaggi, D.A., "Monitoring for PAH and Criteria Pollutants in Contra Costa County, Ca., 1979-1986", APCA Paper 87-96.4, June 1987.

Levaggi, D.A., et al., "Experiences in Gaseous Toxic Monitoring in the San Francisco Bay Area", APCA Paper 88-95A.3., June, 1988.

Santa Clara Valley Integrated Environmental Management Project, Revised Stage I Report, EPA, May 1986.

The Air Toxics Problem in the United States: An Analysis of Cancer Risks for Selected Pollutants, EPA, May 1985.

Users' Instructions for the SHORTZ and LONGZ Computer Programs, Volumes I and II, Bjorklund, J.R., and Bowers, J.F., 1982.

APPENDIX A

TOXIC AIR CONTAMINANT EMISSIONS
BY SOURCE CATEGORY
CONTRA COSTA COUNTY

APPENDIX A

TABLE OF CONTENTS

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR

A.1 **BENZENE**

CAT	DESCRIPTION	TX1 BNZN	PERCENT OF TOTAL
	OTHER INDUSTRIAL/COMMERCIAL		
221	Oil Production Fields	.009	.00
222	Gas Production Fields	1.449	.29
271	Sewage Treatment Plants	.110	.02
	Subtotal:	1.568	.31
	PETROLEUM REFINERY EVAPORATION		
47	Storage and Blending	2.743	.55
48	Loading	7.841	1.57
	Subtotal:	10.584	2.12
	FUELS DISTRIBUTION		
50	Bulk Plants - Storage Tanks	1.085	.22
51	Bulk Plants - Loading Trucks	2.410	.48
52	Trucking	.119	.02
53	Filling Stations - Spillage	1.016	.20
54	Filling Stations - Storage Tanks	.586	.12
55	Filling Stations - Vehicle Tanks	1.245	.25
	Subtotal:	6.461	1.29
	OTHER ORGANIC COMPOUNDS EVAPORATION		
57	Storage Tanks - Solvents	5.584	1.12
58	Storage Tanks - Other Organics	.051	.01
231	Structures Coating - Water Base	1.004	.20
256	Lightering & Gas Freeing	.233	.05
257	Ballasting - Crude Oil	.023	.00
259	Marine Loading (Non Refinery)	.324	.06
	Subtotal:	7.220	1.44
	STATIONARY FUEL COMBUSTION		
83	Domestic - Gas	.082	.02
85	Domestic - Solid	6.659	1.33
86	Commercial & Institutional - Gas	.018	.00
87	Commercial & Institutional - Oil	.026	.01
88	Oil Refineries Ext Combust - NG	.036	.01
89	Refineries Ext Combust - RMG	.404	.08
90	Refineries Ext Combust - Fuel Oil	.016	.00
92	Power Plants - NG fired Boilers	.076	.02
98	Asphaltic Concrete Plants - Oil	.001	.00
99	Kilns - Gas	.002	.00

(CONTINUED)

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (CONT.)

BENZENE

CAT	DESCRIPTION	TX1 BNZN	PERCENT OF TOTAL
STATIONARY FUEL COMBUSTION (CONT.)			
100	Kilns - Oil	.017	.00
102	Turbines - Gas	.009	.00
104	Recip Engs - Gasoline, Domestic	6.103	1.22
105	Recip Engs - All Other Gasoline	9.439	1.89
106	Recip Engs - Gas Fueled	.413	.08
107	Recip Engs - Oil Fueled	.618	.12
109	Cogeneration	.259	.05
111	Other Combustion - NG	.045	.01
112	Other Combustion - Oil	.001	.00
113	Other Combustion - LPG	.000	.00
115	Other Combustion - Other Fuels	.000	.00
Subtotal:		24.222	4.85
BURNING OF WASTE MATERIAL			
265	Incineration	.095	.02
120	Agricultural Debris Burning	.199	.04
Subtotal:		.294	.06
MISC EMISSION SOURCES			
170	Accidential Fires - Vegetation	.793	.16
217	Pesticides - Synth (Non Domestic)	8.238	1.65
218	Pesticides - Non Synthetic	15.534	3.11
Subtotal:		24.565	4.91
OFF-ROAD MOBILE SOURCES			
123	Farm Equipment - Gasoline	1.702	.34
124	Farm Equipment - Diesel	.571	.11
125	Construction Equipment - Gasoline	2.821	.56
126	Construction Equipment - Diesel	2.292	.46
192	Motorships - Cargo	1.301	.26
194	Motorships - Tankers	.512	.10
135	Commercial Fishing Boats	.294	.06
136	Pleasure Boats - Diesel	.630	.13
137	Pleasure Boats- Gasoline- 2-stroke	46.757	9.35
138	Pleasure Boats- Gasoline- 4-stroke	2.422	.48
139	Locomotives	2.670	.53
166	Motorcycles (off-road) - 2 Stroke	2.407	.48
Subtotal:		64.379	12.88

(CONTINUED)

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (CONT.)

BENZENE

CAT	DESCRIPTION	TX1 BNZN	PERCENT OF TOTAL
AIRCRAFT			
143	General Aviation - Jet	.311	.06
144	General Aviation - Piston	1.901	.38
145	Military - Jet	.002	.00
146	Military - Piston	.215	.04
Subtotal:		2.429	.49
ON-ROAD MOBILE SOURCES			
148	Light Duty Vehicles - Exhaust	233.685	46.75
149	- Evaporation	60.017	12.01
152	Medium Duty Gas Vehicles - Exhaust	14.859	2.97
153	- Evaporation	2.760	.55
156	Heavy Duty Gas Vehicles - Exhaust	23.090	4.62
157	- Evaporation	5.902	1.18
160	Diesel Trucks - Exhaust	12.928	2.59
164	Motorcycles (on-road) - 2 Stroke	4.599	.92
165	- 4 Stroke	.261	.05
Subtotal:		358.101	71.65
Grand Total:		**499.824**	**100.00**

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR

A.2 CARBON TETRACHLORIDE

CAT	DESCRIPTION	TX2 CTET	PERCENT OF TOTAL
CHEMICAL MFG			
19	Other Chemicals Mfg	71.786	95.52
OTHER ORGANIC COMPOUNDS EVAPORATION			
57	Storage Tanks - Solvents	1.966	2.62
234	Ind/Commercial Coating -Can & Coil	1.400	1.86
Subtotal:		3.366	4.48
Grand Total:		**75.152**	**100.00**

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR

A.3 CHLOROFORM

CAT	DESCRIPTION	TX3 CLFM	PERCENT OF TOTAL
OTHER INDUSTRIAL/COMMERCIAL			
271	Sewage Treatment Plants	3.050	42.58
OTHER ORGANIC COMPOUNDS EVAPORATION			
268	Drinking Water Chlorination	4.113	57.42
Grand Total:		**7.163**	**100.00**

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR

A.4 DICHLOROMETHANE (METHYLENE CHLORIDE)

CAT	DESCRIPTION	TX4 DCLM	PERCENT OF TOTAL
CHEMICAL MFG			
19	Other Chemicals Mfg	58.275	11.08
OTHER INDUSTRIAL/COMMERCIAL			
271	Sewage Treatment Plants	2.851	.52
OTHER ORGANIC COMPOUNDS EVAPORATION			
57	Storage Tanks - Solvents	3.725	.68
230	Structures Coating - Oil Base	13.448	2.45
231	Structures Coating - Water Base	11.968	2.18
250	Degreasers - Syn Solvent Mfg	1.820	.33
251	Degreasers - Petroleum Solvent Mfg	.975	.18
252	Degreasers- Industrial Maintenance	1.462	.27
253	Degreasers- Commercial Maintenance	9.517	1.73
81	Other Organics Evaporation	125.970	22.96
	Subtotal:	168.885	30.78
MISC EMISSION SOURCES			
180	Consumer Products - Non Aerosol	148.200	27.02
181	Consumer Products- Aerosol Product	170.430	31.06
	Subtotal:	318.630	58.08
	Grand Total:	**548.641**	**100.00**

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR

A.5 1,4-DIOXANE

CAT	DESCRIPTION	TX5 DIOX	PERCENT OF TOTAL
OTHER ORGANIC COMPOUNDS EVAPORATION			
57	Storage Tanks - Solvents	.171	4.48
244	Industrial Coating - Other	.113	2.97
250	Degreasers - Syn Solvent Mfg	1.310	34.31
81	Other Organics Evaporation	.815	21.35
Subtotal:		2.409	63.11
MISC EMISSION SOURCES			
180	Consumer Products - Non Aerosol	.741	19.42
181	Consumer Products- Aerosol Product	.667	17.47
Subtotal:		1.408	36.89
Grand Total:		**3.817**	**100.00**

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR

A.6 ETHYLENE DIBROMIDE

CAT	DESCRIPTION	TX6 EDB	PERCENT OF TOTAL
PETROLEUM REFINERY EVAPORATION			
47	Storage and Blending	.002	1.32
48	Loading	.005	3.77
Subtotal:		.007	5.08
FUELS DISTRIBUTION			
50	Bulk Plants - Storage Tanks	.001	.52
51	Bulk Plants - Loading Trucks	.002	1.16
53	Filling Stations - Spillage	.001	.46
54	Filling Stations - Storage Tanks	.000	.01
Subtotal:		.003	2.15
OTHER ORGANIC COMPOUNDS EVAPORATION			
58	Storage Tanks - Other Organics	.000	.02
259	Marine Loading (Non Refinery)	.000	.16
Subtotal:		.000	.18
STATIONARY FUEL COMBUSTION			
104	Recip Engs - Gasoline, Domestic	.007	5.27
105	Recip Engs - All Other Gasoline	.006	4.12
Subtotal:		.013	9.38
OFF-ROAD MOBILE SOURCES			
123	Farm Equipment - Gasoline	.001	.71
125	Construction Equipment - Gasoline	.002	1.17
137	Pleasure Boats- Gasoline- 2-stroke	.024	17.08
138	Pleasure Boats- Gasoline- 4-stroke	.001	.88
166	Motorcycles (off-road) - 2 Stroke	.001	.87
Subtotal:		.029	20.71
AIRCRAFT			
144	General Aviation - Piston	.026	18.98
146	Military - Piston	.003	2.15
Subtotal:		.029	21.13
ON-ROAD MOBILE SOURCES			
148	Light Duty Vehicles - Exhaust	.031	21.94
149	- Evaporation	.011	8.10

(CONTINUED)

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (CONT.)

ETHYLENE DIBROMIDE

CAT	DESCRIPTION	TX6 EDB	PERCENT OF TOTAL
ON-ROAD MOBILE SOURCES (CONT.)			
152	Medium Duty Gas Vehicles - Exhaust	.004	2.51
153	- Evaporation	.001	.57
156	Heavy Duty Gas Vehicles - Exhaust	.008	5.41
157	- Evaporation	.002	1.45
164	Motorcycles (on-road) - 2 Stroke	.002	1.10
165	- 4 Stroke	.000	.29
Subtotal:		.058	41.37
Grand Total:		**.139**	**100.00**

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR

A.7 ETHYLENE OXIDE

CAT	DESCRIPTION	TX7 ETOX	PERCENT OF TOTAL
OTHER INDUSTRIAL/COMMERCIAL			
269	Hospital Sterilizers	1.580	99.39
OTHER ORGANIC COMPOUNDS EVAPORATION			
57	Storage Tanks - Solvents	.010	.61
Grand Total:		**1.590**	**100.00**

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR

A.8 FORMALDEHYDE

CAT	DESCRIPTION	TX8 FMLD	PERCENT OF TOTAL
PETROLEUM REFINING			
10	Refining Processes	11.070	2.52
OTHER ORGANIC COMPOUNDS EVAPORATION			
81	Other Organics Evaporation	3.705	.84
STATIONARY FUEL COMBUSTION			
83	Domestic - Gas	9.444	2.15
84	Domestic - Liquid	.002	.00
85	Domestic - Solid	144.000	32.78
86	Commercial & Institutional - Gas	.178	.04
87	Commercial & Institutional - Oil	.006	.00
88	Oil Refineries Ext Combust - NG	.220	.05
89	Refineries Ext Combust - RMG	2.282	.52
90	Refineries Ext Combust - Fuel Oil	.091	.02
92	Power Plants - NG fired Boilers	.081	.02
98	Asphaltic Concrete Plants - Oil	.005	.00
100	Kilns - Oil	.059	.01
104	Recip Engs - Gasoline, Domestic	1.831	.42
105	Recip Engs - All Other Gasoline	3.306	.75
106	Recip Engs - Gas Fueled	.082	.02
107	Recip Engs - Oil Fueled	.787	.18
109	Cogeneration (**)	40.420	9.20
111	Other Combustion - NG	2.109	.48
112	Other Combustion - Oil	.005	.00
Subtotal:		204.909	46.64
BURNING OF WASTE MATERIAL			
265	Incineration	8.301	1.89
120	Agricultural Debris Burning	2.344	.53
Subtotal:		10.645	2.42
MISC EMISSION SOURCES			
170	Accidential Fires - Vegetation	9.467	2.15
180	Consumer Products - Non Aerosol	4.891	1.11
Subtotal:		14.358	3.27

(CONTINUED)

...CMD
...RARY

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (CONT.)

FORMALDEHYDE

CAT	DESCRIPTION	TX8 FMLD	PERCENT OF TOTAL
	OFF-ROAD MOBILE SOURCES		
123	Farm Equipment - Gasoline	1.305	.30
124	Farm Equipment - Diesel	2.978	.68
125	Construction Equipment - Gasoline	1.914	.44
126	Construction Equipment - Diesel	9.576	2.18
192	Motorships - Cargo	1.816	.41
194	Motorships - Tankers	.715	.16
135	Motorships - Fishing Boats	.410	.09
136	Pleasure Boats - Diesel	1.678	.38
137	Pleasure Boats- Gasoline- 2-stroke	4.453	1.01
138	Pleasure Boats- Gasoline- 4-stroke	.877	.20
139	Locomotives	4.062	.92
166	Motorcycles (off-road) - 2 Stroke	.229	.05
	Subtotal:	30.013	6.83
	AIRCRAFT		
143	General Aviation - Jet	.726	.17
145	Military - Jet	.005	.00
146	Military - Piston	1.070	.24
	Subtotal:	1.801	.41
	ON-ROAD MOBILE SOURCES		
148	Light Duty Vehicles - Exhaust	116.166	26.44
152	Medium Duty Gas Vehicles - Exhaust	11.231	2.56
156	Heavy Duty Gas Vehicles - Exhaust	14.819	3.37
160	Diesel Trucks - Exhaust	18.025	4.10
164	Motorcycles (on-road) - 2 Stroke	2.355	.54
165	Motorcycles - 4 Stroke	.247	.06
	Subtotal:	162.843	37.06
	Grand Total:	**439.345**	**100.00**

(**) Emissions are from a single industrial waste-wood boiler.

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR

A.9 PERCHLOROETHYLENE

CAT	DESCRIPTION	TX9 PERC	PERCENT OF TOTAL
CHEMICAL MFG			
19	Other Chemicals Mfg	32.576	11.67
OTHER INDUSTRIAL/COMMERCIAL			
271	Sewage Treatment Plants	.571	.20
OTHER ORGANIC COMPOUNDS EVAPORATION			
57	Storage Tanks - Solvents	3.444	1.23
251	Degreasers - Petroleum Solvent Mfg	1.717	.62
252	Degreasers- Industrial Maintenance	3.603	1.29
253	Degreasers- Commercial Maintenance	16.765	6.01
71	Dry Cleaners - Perchloroethylene	154.252	55.28
Subtotal:		179.781	64.43
MISC EMISSION SOURCES			
180	Consumer Products - Non Aerosol	58.142	20.84
181	Consumer Products- Aerosol Product	7.981	2.86
Subtotal:		66.123	23.70
Grand Total:		**279.051**	**100.00**

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR

A.10 **PHENOL**

CAT	DESCRIPTION	TX10 PHNL	PERCENT OF TOTAL
PETROLEUM REFINERY EVAPORATION			
47	Storage and Blending	.171	.06
48	Loading	.027	.01
Subtotal:		.199	.07
STATIONARY FUEL COMBUSTION			
85	Domestic - Solid	97.920	36.80
109	Cogeneration (**)	167.986	63.13
Subtotal:		265.906	99.93
Grand Total:		**266.105**	**100.00**

(**) Emissions are from a single industrial waste-wood boiler.

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR

A.11 TRICHLOROETHYLENE

CAT	DESCRIPTION	TX11 TCE	PERCENT OF TOTAL
OTHER INDUSTRIAL/COMMERCIAL			
271	Sewage Treatment Plants	.030	.62
OTHER ORGANIC COMPOUNDS EVAPORATION			
57	Storage Tanks - Solvents	1.852	38.42
250	Degreasers - Syn Solvent Mfg	2.938	60.96
	Subtotal:	4.790	99.38
	Grand Total:	**4.820**	**100.00**

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR

A.12 VINYL CHLORIDE

CAT	DESCRIPTION	TX12 VNCL	PERCENT OF TOTAL

NO POINT, AREA, OR MOBILE SOURCES OF VINYL CHLORIDE WERE IDENTIFIED IN THIS STUDY.

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR

A.13 ARSENIC (INORGANIC)

CAT	DESCRIPTION	TX13 ARSN	PERCENT OF TOTAL
STATIONARY FUEL COMBUSTION			
84	Domestic - Liquid	.001	1.15
87	Commercial & Institutional - Oil	.003	4.18
90	Refineries Ext Combust - Fuel Oil	.026	27.49
93	Power Plants - Oil fired Boilers	.004	3.98
98	Asphaltic Concrete Plants - Oil	.000	.01
100	Kilns - Oil	.000	.01
111	Other Combustion - Oil	.002	1.72
115	Other Combustion - Other Fuels (**)	.059	61.46
Grand Total:		**.096**	**100.00**

(**) Emissions are from combustion of sewage sludge.

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR

A.14 CADMIUM

CAT	DESCRIPTION	TX14 CADM	PERCENT OF TOTAL
	STATIONARY FUEL COMBUSTION		
90	Refineries Ext Combust - Fuel Oil	.026	10.60
92	Power Plants - Oil fired Boilers	.003	1.23
104	Recip Engs - Gasoline, Domestic	.001	.34
105	Recip Engs - All Other Gasoline	.002	.63
107	Recip Engs - Oil Fueled	.035	13.86
112	Other Combustion - Oil	.001	.53
115	Other Combustion - Other Fuels	.003	1.43
	Subtotal:	.073	28.64
	BURNING OF WASTE MATERIAL		
265	Incineration	.019	7.26
	OFF-ROAD MOBILE SOURCES		
123	Farm Equipment - Gasoline	.001	.39
124	Farm Equipment - Diesel	.003	1.06
125	Construction Equipment - Gasoline	.001	.27
126	Construction Equipment - Diesel	.010	3.77
192	Motorships - Cargo	.003	1.33
194	- Tankers	.002	.71
135	- Fishing Boats	.000	.16
136	Pleasure Boats - Diesel	.000	.20
137	Pleasure Boats- Gasoline- 2-stroke	.001	.39
139	Locomotives	.005	2.08
	Subtotal:	.026	10.37
	AIRCRAFT		
144	General Aviation - Piston	.000	.12
	ON-ROAD MOBILE SOURCES		
148	Light Duty Vehicles - Exhaust	.023	9.07
151	- Tire/Brake Lining Wear	.009	3.53
152	Medium Duty Gas Vehicles - Exhaust	.001	.57
155	- Tire/Brake Lining Wear	.000	.20
156	Heavy Duty Gas Vehicles - Exhaust	.002	.86
159	- Tire/Brake Lining Wear	.000	.12
160	Diesel Trucks - Exhaust	.100	39.13
161	- Tire Wear	.000	.13
	Subtotal:	.137	53.61
	Grand Total:	**.255**	**100.00**

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR

A.15 CHROMIUM

CAT	DESCRIPTION	TX15 CHRM	PERCENT OF TOTAL
	OTHER INDUSTRIAL/COMMERCIAL		
270	Chrome Plating	.009	.55
	STATIONARY FUEL COMBUSTION		
87	Commercial & Institutional - Oil	.003	.25
90	Refineries Ext Combust - Fuel Oil	.000	.02
107	Recip Engs - Oil Fueled	.320	19.85
115	Other Combustion - Other Fuels	.008	.42
	Subtotal:	.331	20.54
	BURNING OF WASTE MATERIAL		
265	Incineration	.010	.65
120	Agricultural Debris Burning	.000	.02
	Subtotal:	.011	.67
	MISC EMISSION SOURCES		
170	Accidential Fires - Vegetation	.004	.27
266	Cooling Towers - Industrial	.093	5.77
	Subtotal:	.097	6.04
	OFF-ROAD MOBILE SOURCES		
124	Farm Equipment - Diesel	.024	1.51
126	Construction Equipment - Diesel	.087	5.38
135	- Fishing Boats	.003	.22
136	Pleasure Boats - Diesel	.008	.52
139	Locomotives	.048	2.97
	Subtotal:	.171	10.60
	ON-ROAD MOBILE SOURCES		
148	Light Duty Vehicles - Exhaust	.091	5.64
160	Diesel Trucks - Exhaust	.902	55.97
	Subtotal:	.992	61.61
	Grand Total:	**1.611**	**100.00**

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR

A.16 POLYCYCLIC AROMATIC HYDROCARBONS

CAT	DESCRIPTION	TX16 PAH	PERCENT OF TOTAL
STATIONARY FUEL COMBUSTION			
83	Domestic - Gas	.007	.06
85	Domestic - Solid	3.302	26.48
87	Commercial & Institutional - Oil	.003	.02
90	Refineries Ext Combust - Fuel Oil	.027	.22
93	Power Plants - Oil fired Boilers	.002	.01
104	Recip Engs - Gasoline, Domestic	.046	.37
105	Recip Engs - All Other Gasoline	.165	1.33
107	Recip Engs - Oil Fueled	.999	8.01
111	Other Combustion - NG	.717	5.75
115	Other Combustion - Other Fuels	.088	.70
Subtotal:		5.355	42.95
BURNING OF WASTE MATERIAL			
265	Incineration	.338	2.71
120	Agricultural Debris Burning	.002	.02
Subtotal:		.340	2.73
MISC EMISSION SOURCES			
170	Accidential Fires - Vegetation	.049	.39
OFF-ROAD MOBILE SOURCES			
123	Farm Equipment - Gasoline	.045	.36
124	Farm Equipment - Diesel	.069	.56
125	Construction Equipment - Gasoline	.074	.59
126	Construction Equipment - Diesel	.279	2.24
192	Motorships - Cargo	.158	1.27
194	Motorships - Tankers	.062	.50
135	Commercial Fishing Boats	.036	.29
136	Pleasure Boats - Diesel	.151	1.21
137	Pleasure Boats- Gasoline- 2-stroke	.334	2.68
138	Pleasure Boats- Gasoline- 4-stroke	.040	.32
139	Locomotives	.325	2.61
166	Motorcycles (off-road) - 2 Stroke	.017	.14
Subtotal:		1.590	12.75
AIRCRAFT			
143	General Aviation - Jet	.021	.17
144	General Aviation - Piston	.032	.25
146	Military - Piston	.004	.03
Subtotal:		.057	.45

(CONTINUED)

TOTAL EMISSIONS BY SOURCE CATEGORY
CONTRA COSTA COUNTY - TONS PER YEAR (CONT.)

POLYCYCLIC AROMATIC HYDROCARBONS

CAT	DESCRIPTION	TX16 PAH	PERCENT OF TOTAL
ON-ROAD MOBILE SOURCES			
148	Light Duty Vehicles - Exhaust	2.228	17.87
152	Medium Duty Gas Vehicles - Exhaust	.315	2.53
156	Heavy Duty Gas Vehicles - Exhaust	.929	7.45
160	Diesel Trucks - Exhaust	1.567	12.57
164	Motorcycles (on-road) - 2 Stroke	.029	.23
165	Motorcycles - 4 Stroke	.009	.07
Subtotal:		5.077	40.72
Grand Total:		**12.468**	**100.00**

APPENDIX B

TOXIC AIR CONTAMINANT POINT SOURCE EMISSIONS INVENTORY METHODOLOGY

B. POINT SOURCE INVENTORY METHODOLOGY

B.1 BAAQMD DATA BANK

Information in the BAAQMD data bank was used as a foundation for developing the point source inventory. The data bank contains detailed information regarding a substantial number of individual sources that operate under BAAQMD permits. The emissions of criteria pollutants are routinely calculated for each source in the data bank. More recently, emission calculations have been extended to include a number of TACs for which emissions data exists. Air toxics emission calculations are made using the following methods:

(1) By applying emission factors to throughput information for specific source operations. Source operations are categorized in the BAAQMD data bank by "source codes". A list of TAC emission factors and species fractions used for specific source codes is given in Table B-1.

(2) By applying species fractions to criteria pollutant emission totals for specific source operations. The data bank contains annual average emission estimates of criteria pollutants for each source based on recent source activity.

(3) By material balance, where a particular toxic substance is identified as a material used directly in a process. For example, solvent evaporative emissions were calculated by assuming that net solvent usage (i.e. purchases minus the amount reclaimed/recycled) equals emissions.

The TAC emission inventory generated using data bank information cannot be considered to be complete. Reliable TAC emission factors or species fractions have not yet been developed for a number of source types (e.g. flares). Of particular concern is the lack of fugitive organic TAC emission estimates from such sources as process vents, pumps, compressors, and pressure relief valves at refineries.

Another concern with the use of the data bank is that emissions from certain non-traditional sources may be omitted. In general, sources have been included in the data bank because they emit criteria pollutants. Certain sources may not be significant criteria pollutant emission sources, but may nonetheless be significant contributors to total TAC emissions. Included in this category of non-traditional sources are hospital sterilizers, cooling towers, and hazardous, industrial, and municipal waste treatment and disposal facilities.

Two notable omissions from the study due to insufficient emissions information were the International Technology (IT) Corporation Vine Hill hazardous waste treatment facility and the IT Panoche hazardous waste disposal facility. Comprehensive risk evaluations for these facilities were being prepared at the time that this study was being finalized.

B.2 ADDITIONAL EMISSION ESTIMATES

The point source inventory developed using information in the BAAQMD data bank was augmented with additional available information regarding point source TAC emissions. The following additional information was used in compiling the final point source inventory:

(1) Chemical Plant Fugitive Organic TAC Emissions

In their development of emission standards for chemical plants, EPA has issued several reports containing fugitive organic TAC emission estimates for specific chemical production facilities. Fugitive TAC emission estimates for chemical plants in Contra Costa County were derived from information in the following EPA technical reports:

(a) "Pesticide Manufacturing Facilities", OAQPS, Emission Standards and Engineering Division.
(b) "Chlorinated Hydrocarbon Production", OAQPS, Emission Standards and Engineering Division.
(c) "Emissions from the Use of Chlorinated Compounds in Chemical Plants", OAQPS, Emission Standards and Engineering Division.

It is possible that these reports overestimate fugitive TAC emissions. The estimates were based upon EPA "average" emission factors, which is the least refined approach for these calculations. Data being gathered for purposes of complying with Title III of the Superfund Amendments and Reauthorization Act (SARA) should produce more accurate emission estimates.

(2) Ethylene Oxide Emissions from Hospital Sterilizers

Hospital sterilizers were the only identified sources of ethylene oxide. The BAAQMD is currently involved in obtaining information regarding hospital sterilizer emissions by survey questionnaire. Emissions were calculated from survey results by material balance assuming that 100% of reported ethylene oxide use was emitted. About one-third of the questionnaires sent out in Contra Costa and Solano Counties had not been returned when the inventory was being compiled. The emissions from these facilities could not be included in the emissions inventory.

(3) Sewage Treatment Plant Organic TAC Emissions

Organic TAC emission estimates for two sewage treatment plants were included in the inventory as reported in a University of California at Davis study, "Emissions of Volatile and Potentially Toxic Organic Compounds from Sewage Treatment Plants and Collection Systems" (CARB publication #A5-127-32). Annual emission estimates are given in this report for benzene, carbon tetrachloride, chloroform, methylene chloride, trichloroethylene, and vinyl chloride.

(4) TAC Emissions from Sewage Sludge Incineration

Trace metal and PAH emission factors for sewage sludge incineration had not been included in the data bank when the inventory was being compiled. Emissions from these sources were calculated from reported sludge throughput data and emission factors taken from EPA documents (the factor for cadmium was derived from, "Characterization of Particulate Emissions from Municipal Wastewater Sludge Incinerators", Bennet and Knapp, ES&T Vol. 16 (12), 1982). The emission factors used are listed in the following table.

EMISSION FACTORS USED FOR SEWAGE SLUDGE INCINERATION

TAC	Emission Factor	Reference
Arsenic	0.0039 lb/ton sludge	(EPA-450/4-86-010a)
Chromium	0.0005 lb/ton sludge	(EPA-450/4-86-010a)
PAHs	0.0058 lb/ton sludge	(EPA-450/4-84-007p)
Cadmium	0.0002 lb/ton sludge	Bennet and Knapp

(5) Chromium Emissions from Chrome Plating Facilities

The BAAQMD is currently conducting a survey to obtain information regarding emissions from chrome plating facilities. Hexavalent chromium emissions were calculated from survey results by applying a CARB emission factor of 5.2 mg/amp-hr to reported facility activity data. Three out of seven questionnaires sent out in Contra Costa and Solano Counties had not been returned when the inventory was being compiled. The emissions from the non-responsive facilities were not included in the emissions inventory.

TABLE B-1

POINT SOURCE EMISSION FACTORS/SPECIES FRACTIONS

POLLUTANT	SOURCE OPERATION	SOURCE CODE(S)	EMISSION FACTOR	REFERENCE
Benzene	Any Unspecified Combustion:			
	Crude Oil	Cxxx0089	1.8% of THC	"Benzene Regulatory Needs Report", Draft, Feb. 1986, pg. A-11.
	Diesel	Cxxx0098	"	
	Residual Oil (#6)	Cxxx0242	"	
	Distillate Oil	Cxxx0392	"	
	Fuel Oil (#2)	Cxxx0392	"	
	Any Unspecified Combustion:			
	Natural Gas	Cxxx0189	0.11% of THC	"Benzene Regulatory Needs Report", Draft, Feb. 1986, Pg. A-11.
	Refinery Make Gas	Cxxx0238	"	
	Process Gas	Cxxx0237	"	
	Propane	Cxxx0160	"	
	Asphalt Plant	G4021030	0.0027 lb per ton asphalt	"Phoenix and Tuscon Air Toxics Emission Inventory Study", Radian Corp., Jan. 1986, Pg. B-3.
	Gasoline Marketing	Txxxx128	1.0% of THC	"Benzene Regulatory Needs Report", Draft, Feb. 1986, pg. A-1.
1,4-Dioxane	TCA Solvent Degreasing	SDxxx294	3.0% of TCA	"Evaluation of Potential Toxic Air Contaminants", SAIC, Draft, March 1987.
Ethylene Dibromide	Gasoline Marketing	Txxxx128	0.0007% of THC	"Need for Controlling Airborne Ethylene Dibromide", CARB, Sept. 1986, pg. A-11.
Formaldehyde	Any Unspecified Combustion:			
	Diesel	Cxxx0098	0.055 lb per thou. gallon	"Summary of Trace Emissions ... Coal and Oil Combustion Sources", Radian Corp., External Review Draft, pp.3-36-49.
	Distillate Oil	Cxxx0315	0.056 lb per thou. gallon	
	Fuel Oil (#2)	Cxxx0392	"	
	Residual Oil (#6)	Cxxx0242	0.062 lb per thou. gallon	
	Wood	Cxxx0304 Cxxx0305	0.48 lb/ton "	"Compiling Air Toxics Emission Inventories", EPA 450/4-86-010.
	Stationary Diesel Engine	C22x0098	4.17 lb per thou. gallon	EPA 450/4-84-007e, pg. 84.
		C25x0098	"	

(CONTINUED)

POINT SOURCE EMISSION FACTORS/SPECIES FRACTIONS (CONT.)

POLLUTANT	SOURCE OPERATION	SOURCE CODE(S)	EMISSION FACTOR	REFERENCE
Formaldehyde (Cont.)	Asphalt Plant	G4021030	0.00015 lb per ton asphalt	AP-42, pg. 8.1-7.
	Coffee Roasting	G1008078 G1011078	6.3% of THC "	"Evaluation of Potential Toxic Air Contaminants", SAIC, Draft Final Report, March, 1987.
	Refinery Fluid Coker w/CO Boiler/Scrubber	G5009346	1.189 lb per thou. bbl feed	"
	Industrial Boiler:			
	Natural Gas	C11x0189	0.000093 lb per thou cu. feet	EPA 450/4-84-007e, pg. 84.
	Refinery Make Gas	C11x0238	"	
	Process Gas	C11x0237	"	
	Propane	C11x0160	"	
	Commercial Boiler:			
	Natural Gas	C12x0189	0.000093 lb per thou cu. feet	EPA 450/4-84-007e, pg. 84.
	Refinery Make Gas	C12x0238	"	
	Process Gas	C12x0237	"	
	Propane	C12x0160	"	
	Space Heat Boiler:			
	Natural Gas	C13x0189	0.000093 lb per thou cu. feet	EPA 450/4-84-007e, pg. 84.
	Refinery Make Gas	C13x0238	"	
	Process Gas	C13x0237	"	
	Propane	C13x0160	"	
	Gas Turbine:			
	Natural Gas	C18x0189	0.0098 lb per thou cu. feet	EPA 450/4-84-007e, pg. 84.
	Refinery Make Gas	C18x0238	"	
	Process Gas	C18x0237	"	
	Propane	C18x0160	"	
	Recip. Engine (Elec. Prod.):			
	Natural Gas	C22x0189	0.014 lb per thou cu. feet	EPA 450/4-84-007e, pg. 84.
	Refinery Make Gas	C22x0238	"	
	Process Gas	C22x0237	"	
	Propane	C22x0160	"	
	Recip. Engine (Testing):			
	Natural Gas	C25x0189	0.014 lb per thou cu. feet	EPA 450/4-84-007e, pg. 84.
	Refinery Make Gas	C25x0238	"	

(CONTINUED)

POINT SOURCE EMISSION FACTORS/SPECIES FRACTIONS (CONT.)

POLLUTANT	SOURCE OPERATION	SOURCE CODE(S)	EMISSION FACTOR	REFERENCE
Formaldehyde (Cont.)	Process Gas	C25x0237	"	
	Propane	C25x0160	"	EPA 450/4-84-007e
Phenol	Unspecified Wood Combustion	Cxxx0304	2.0 lb/ton	"Compiling Air Toxics Emission Inventories", EPA 450/4-86-010.
		Cxxx0305	"	
Arsenic	Any Unspecified Combustion:			
	Distillate Oil	Cxxx0315	0.00058 lb per thou. gallon	"Summary of Trace Emissions ... Coal and Oil Combustion Sources", Radian Corp., External Review Draft, pp.3-36-49.
	Fuel Oil (#2)	Cxxx0392	"	
	Residual Oil (#6)	Cxxx0242	0.0029 lb per thou. gallon	
Cadmium	Any Unspecified Combustion:			
	Distillate Oil	Cxxx0315	0.0014 lb per thou. gallon	"Summary of Trace Emissions ... Coal and Oil Combustion Sources", Radian Corp., External Review Draft, pp.3-36-49.
	Fuel Oil (#2)	Cxxx0392	"	
	Residual Oil (#6)	Cxxx0242	0.0024 lb per thou. gallon	
Chromium (Hexavalent)	Any Unspecified Combustion:			
	Distillate Oil	Cxxx0315	0.00003 lb per thou. gallon	"Summary of Trace Emissions ... Coal and Oil Combustion Sources", Radian Corp., External Review Draft, pp.3-36-49.
	Fuel Oil (#2)	Cxxx0392	"	
	Residual Oil (#6)	Cxxx0242	0.00002 lb per thou. gallon	
PAHs	Any Unspecified Combustion:			
	Distillate Oil	Cxxx0315	0.0031 lb per thou. gallon	"Summary of Trace Emissions ... Coal and Oil Combustion Sources", Radian Corp., External Review Draft, pp.3-36-49.
	Fuel Oil (#2)	Cxxx0392	"	
	Residual Oil (#6)	Cxxx0242	0.0013 lb per thou. gallon	
	Diesel Oil	Cxxx0098	0.0031 lb per thou. gallon	
	Asphalt Plant	G4021030	0.000026 lb per ton asphalt	AP-42, pg. 8.1-7.
	Refinery FCC Unit with CO Boiler	G5007344	0.00057 lb per	EPA 450-14-84-007p.

APPENDIX C

TOXIC AIR CONTAMINANT AREA AND MOBILE SOURCE EMISSIONS INVENTORY METHODOLOGY

APPENDIX C

TABLE OF CONTENTS

C.1 BENZENE

C.1.1 AREA SOURCES

Area source categories of benzene emissions include fuel combustion and waste burning, gasoline marketing, oil and gas extraction, and surface coatings and pesticide use. Most of the emission estimates were made by multiplying the annual THC emissions for a given category by a benzene species fraction. Most of the species fractions were taken from CARBs Technical Support Document to Proposed Benzene Control Plan (1986). For categories with point and area source components, the area source emissions were taken to be the total county emissions minus the emissions from point sources in that category. The factors used in calculating benzene emissions are summarized in the table below:

BENZENE SPECIES FRACTIONS FOR AREA SOURCES

CAT	DESCRIPTION	SPECIES FRACTION/EMISSION FACTOR
Fuel Combustion		
85	Domestic Wood Combustion	0.14 lb/ton-wood (1)
83	Domestic Gas Combustion	0.11% of THC (2)
86	Commercial/Inst Gas Combustion	0.11% of THC (2)
87	Commercial/Inst Fuel Oil Comb.	1.80% of THC (2)
111	Natural Gas Combustion - Other	0.11% of THC (2)
104	Domestic Reciprocating Engines	4.00% of THC (2)
107	Oil-Fired Reciprocating Engines	1.80% of THC (2)
105	Gasoline-Fired Recip Eng. - Other	4.00% of THC (2)
Waste Burning		
120	Agricultural Debris Burning	2.06% of THC (3)
170	Accidental Fires - Vegetation	2.06% of THC (3)
265	Incineration	0.19% of THC (2)
Evaporative Emission Sources		
52	Fuels Distribution - Trucking	1.06% of THC (4)
53	Filling Stations - Spillage	1.06% of THC (4)
54	Filling Stations - Storage Tanks	1.06% of THC (4)
55	Filling Stations - Vehicle Tanks	1.06% of THC (4)
221	Oil Production Fields	0.10% of THC (5)
222	Gas Production Fields	0.10% of THC (5)
256	Lightering and Gas Freeing	0.10% of THC (6)
257	Ballasting - Crude Oil	0.10% of THC (6)
217	Pesticides - Synth (Non Domestic)	12.30% of THC (7)
218	Pesticides - (Non Synthetic)	12.30% of THC (7)
231	Structures Coating (Waterbase)	0.36% of THC (8)

FOOTNOTES FOR TABLE:

(1) This emission factor is reported for wood heating in the CARB Benzene report (CARB, 1986).

FOOTNOTES FOR TABLE (CONT.):

(2) Combustion source species fractions were taken from Table A-8 of the CARB Benzene report.

(3) This species fraction is reported in Table A-9 of the CARB Benzene report as the weighted mean for agricultural burns.

(4) This species fraction was derived as the average benzene content of gasoline for the year 1987 from data in the CARB Benzene report.

(5) This species fraction was given in the CARB Benzene report for oil and gas extraction.

(6) This species fraction was listed in the EPA VOC Species Manual (EPA, 1980) for crude oil evaporation.

(7) This species fraction was listed in the EPA VOC Species Manual for benzene content of a composite of pesticides used in California.

(8) This species fraction was reported for waterbase architectural coatings used in California (Oliver, et al., 1985)

C.1.2 MOBILE SOURCES

The benzene emissions for on-road mobile sources were based on species fractions given in the CARB Benzene report. Different species fractions were given for catalyst, non-catalyst, and diesel exhaust emissions, and for mobile source evaporative emissions. The species fractions used are given below:

BENZENE SPECIES FRACTIONS FOR MOBILE SOURCES

Exhaust:	
Catalyst:	3.45% of THC (derived for the year 1987)
Non-Catalyst:	4.20% of THC
Diesel:	2.30% of THC
Evaporative:	
Gasoline Fueled:	2.10% of THC

THC exhaust and evaporative emission estimates by vehicle class and technology type were provided by CARB for the year 1987 for Contra Costa and Solano Counties (mobile source emissions were actually reported as "total organic gases" (TOG), which were taken to be approximately equal to THC). The benzene emissions were estimated by multiplying the species fractions by the CARB THC estimates.

Benzene emissions from off-road mobile sources were also estimated by using species fractions taken from the CARB Benzene report. The species fractions used for off-road vehicles are listed in the table below:

BENZENE SPECIES FRACTIONS:OFF-ROAD MOBILE SOURCES (% of THC)

CAT	DESCRIPTION	SPECIES FRACTION	
123	Farm Equipment, Gas	4.20%	(1)
124	Farm Equipment, Diesel	2.30%	(2)
125	Construction Equip, Gas	4.20%	(1)
126	Construction Equip, Diesel	2.30%	(2)
135	Commercial Boats, Fishing	2.30%	(2)
136	Pleasure Boats, Diesel	2.30%	(2)
137	Pleas Boat, Gas 2-stroke	4.30%	(1)
138	Pleas Boat, Gas 4-stroke	4.30%	(1)
139	Locomotives	2.30%	(2)
143	General Aviation, Jet	0.60%	(3)
144	General Aviation, Piston	4.20%	(1)
145	Military Jet Aircraft	0.60%	(3)
146	Military Piston Aircraft	4.20%	(1)
147	Agricultural Aircraft	4.20%	(1)
192	Motorships, Cargo	2.30%	(2)
194	Motorships, Tankers	2.30%	(2)
166	Motorcycles, Off-road	4.20%	(1)

FOOTNOTES FOR TABLE:

(1) The species fraction for exhaust emissions from non-catalytic gasoline-fueled vehicles was used.

(2) The species fraction for exhaust emissions from diesel vehicles was used.

(3) The species fraction given in Table A-8 of the ARB Benzene report for jet fuel combustion was used for jet aircraft.

REFERENCES:

Oliver, W.R., et al., Improvement of the Emission Inventory for Reactive Organic Gases and Oxides of Nitrogen in the South Coast Air Basin, Volume II, Systems Applications, Inc., 1985.

Technical Support Document to Proposed Benzene Control Plan, CARB, 1986.

Volatile Organic Compound (VOC) Data Manual, 2nd Edition, EPA/4-80-015, 1980.

C.2 CARBON TETRACHLORIDE

C.2.1 AREA SOURCES

Emissions of carbon tetrachloride are largely associated with activities at chemical plants, which are treated as point sources. Carbon tetrachloride is apparently used to some degree as a solvent and thinner in shoe and furniture polishes, surface coatings, printing inks, and floor waxes (EPA, 1984). Carbon tetrachloride is also present in certain pesticides (SCAQMD, 1983). Emissions from these miscellaneous uses could not be quantified, but are thought to be relatively minor.

C.2.2 MOBILE SOURCES

Mobile sources do not emit carbon tetrachloride, or the emissions are believed to be negligible.

REFERENCES:

Emissions of Potentially Toxic/Hazardous Air Contaminants in the South Coast Air Basin, SCAQMD, September 1983.

Locating and Estimating Air Emissions from Sources of Carbon Tetrachloride, EPA, March 1984.

C.3 CHLOROFORM

C.3.1 AREA SOURCES

Direct sources of chloroform emissions occur primarily at chemical and pharmaceutical plants, which are treated as point sources. Chloroform is also used at hospital and university laboratories, but the emissions from these sources are not expected to be significant (SCAQMD, 1984). Indirect sources of chloroform emissions include cooling tower water and drinking water chlorination. Chloroform is produced from these sources from the reaction of chlorine with organic compounds present in water.

Chlorine is added to cooling tower water to prevent fouling of heat exchanger tubes. A survey completed for CARB indicated that about 25% of industrial cooling towers use chlorinated water (CARB, 1987). Although this is a potentially significant source category, insufficient information is available to quantify emissions at this time.

Most of the chloroform produced from drinking water chlorination occurs in the water distribution system because it takes several days for the reaction to be completed. Emissions are thought to occur during uses of water that tend to disperse and aerate the liquid. Information from EPAs Survey of Chloroform Emission Sources (EPA, 1985) was used to estimate chloroform emissions from drinking water chlorination.

The methodology given in the EPA survey document was followed to estimate emissions from drinking water chlorination, using the average chloroform concentration in water reported for Concord, California (23.5 ug/liter). An average daily water consumption of 587 liters/capita was used, and it was assumed that all of the chloroform in water evaporates during use. The factor used to estimate chloroform emissions from drinking water chlorination is given in the table below:

CHLOROFORM EMISSION FACTOR FOR AREA SOURCES

CAT	DESCRIPTION	EMISSION FACTOR
268	Drinking Water Chlorination	0.011 lb/capita/yr

C.3.2 MOBILE SOURCES

A small amount of chloroform is emitted in the exhaust of gasoline fueled vehicles (SCAQMD, 1987), but these emissions were determined to be negligible.

REFERENCES:

CARB, Personal Communication with Joseph Pantalone, November 1987.

Emissions of Potentially Toxic/Hazardous Air Contaminants in the South Coast Air Basin, SCAQMD, 1983.

Survey of Chloroform Emission Sources, EPA-450/3-85-026, October 1985.

The Magnitude of Ambient Air Toxics Impacts From Existing Sources in the South Coast Air Basin, SCAQMD, June 1987.

C.4 DICHLOROMETHANE (METHYLENE CHLORIDE)

C.4.1 AREA SOURCES

The predominant uses of methylene chloride (MC) are as a constituent in aerosol spray cans and paint removers, which are largely consumer products. Other area source categories of MC include metal cleaning/degreasing operations, architectural surface coatings, and miscellaneous sources such as photographic film processing. Most of the MC emission estimates were made using information in EPAs Survey of Methylene Chloride Emission Sources (1985).

Emission estimates of MC from metal cleaning/degreasing operations were based on emission estimates given for the State of California for the year 1983 in the EPA survey document. The MC emissions for Contra Costa and Solano Counties were estimated by assuming that emissions are proportional to the number of employees in the five primary industry groups that have been reported to use solvent degreasing operations. These industry groups are furniture and fixtures (SIC 25), fabricated metal products (SIC 34), electric and electronic equipment (SIC 36), transportation equipment (SIC 37), and miscellaneous manufacturing industries (SIC 39). County employment data by SIC category for the year 1985 (the most recent year available) was taken from a Bureau of the Census document (1987).

MC emissions from aerosol spray cans, paint removers, and miscellaneous sources were based on national MC consumption information given in the EPA survey document. The MC emissions for Contra Costa and Solano Counties were estimated by assuming that emissions from these categories are proportional to population. It was assumed that all of the MC used in these applications is emitted to the atmosphere.

For categories with point and area source components, the area source emissions were taken to be the total county emissions minus the emissions for point sources in that category. The factors used in calculating MC emissions from area sources are summarized in the table below:

METHYLENE CHLORIDE EMISSION FACTORS FOR AREA SOURCES

CAT	DESCRIPTION	EMISSION FACTOR
251	Solvent Degreasing - Mfg.	0.46 lb/employee/yr (1)
252	Solvent Deg. - Ind. Maint.	0.69 lb/employee/yr (2)
253	Solvent Deg. - Commerc. Maint.	4.49 lb/employee/yr (3)
230	Structures Coating - Oil Base	1.22% of THC (4)

(CONTINUED)

MC EMISSION FACTORS FOR AREA SOURCES (CONT.)

CAT	DESCRIPTION	EMISSION FACTOR
231	Structures Coating - Water Base	5.52% of THC (5)
180	Consumer Products - Non Aerosol	0.40 lb/capita/yr (6)
181	Consumer Products - Aerosol	0.46 lb/capita/yr (7)
81	Other Organics Evaporation	0.34 lb/capita/yr (8)

FOOTNOTES FOR TABLE:

(1) An emission factor of 5.92 lb/employee/yr was calculated for all degreasing operations as the annual MC emissions in California (from the EPA survey document) divided by the total number of employees in five industry groups. The emission factor for degreasing category #251 was calculated by multiplying this factor by the fraction of THC emissions in this category (7.8%).

(2) The emission factor for degreasing category #252 was calculated by multiplying the factor derived for all degreasing operations (5.92 lb/employee/yr) by the fraction of THC emissions in this category (16.3%).

(3) The emission factor for degreasing category #253 was calculated by multiplying the factor for all degreasing operations (5.92 lb/employee/yr) by the fraction of THC emissions in this category (75.9%).

(4) This species fraction was reported for oil base architectural coatings used in California (Oliver, et al., 1985).

(5) This species fraction was reported for waterbase arch itectural coatings used in California (Oliver, et al., 1985).

(6) This factor was based on national MC usage estimates given in the EPA survey document for paint removers, assuming 75% of the total use is in consumer products.

(7) This factor was based on national MC usage estimates given in the EPA survey document for aerosols, assuming 100% of the total use is in consumer products.

(8) This factor was based on national MC usage estimates given in the EPA survey document for paint removers and miscellaneous sources. It was assumed that 25% of the paint remover use and 100% of the miscellaneous uses are in the industrial sector.

C.4.2 MOBILE SOURCES

Mobile sources do not emit MC, or the emissions are believed to be negligible.

REFERENCES:

County Business Patterns 1985, Bureau of the Census, U.S. Department of Commerce, August 1987.

Oliver, W.R., et al., Improvement of the Emission Inventory for Reactive Organic Gases and Oxides of Nitrogen in the South Coast Air Basin, Volume II, Systems Applications, Inc., 1985.

Survey of Methylene Chloride Emission Sources, EPA-450/3-85-015, June 1985.

C.5 1,4-DIOXANE

C.5.1 AREA SOURCES

The primary use of 1,4-dioxane is as a stabilizer in 1,1,1-trichloroethane (TCA) used in solvent metal cleaning/degreasing operations. Emissions also occur from other source categories where TCA is used including aerosol spray cans, adhesives and surface coatings, and various non-aerosol consumer products.

Emission estimates of 1,4-dioxane from metal cleaning/degreasing operations were based on estimates of TCA emissions, assuming an average concentration of 3% by volume of 1,4-dioxane in TCA (SCAQMD, 1983). TCA emissions were based on information on synthetic solvent degreasing given in the BAAQMDs Source Category Methodologies (1983).

Synthetic solvent degreasing involves the use of both TCA and trichloroethylene (TCE) solvents. A solvent survey conducted for CARB in 1976 indicated that TCE use accounted for about 12% of the total synthetic solvent used for degreasing. TCE has gradually been replaced by TCA as a degreasing solvent, at a rate of about 6% per year (SCAQMD, 1983). From this information, 1987 TCA use was estimated to be 95% of the total synthetic solvent used for degreasing.

Emission estimates of 1,4-dioxane from other area source categories were made assuming an average concentration of one percent by volume of 1,4-dioxane in TCA (SCAQMD, 1983). "Per capita" emission factors were derived from national TCA production figures as reported in the Scaqmds Emissions of Potentially Toxic/Hazardous Air Contaminants in the South Coast Air Basin (1983). It was assumed that all of the TCA used is emitted to the atmosphere.

For categories with point and area source components, the area source emissions were taken to be the total county emissions minus the emissions for point sources in that category. The factors used in calculating 1,4-dioxane emissions from area sources are summarized in the following table:

1,4-DIOXANE EMISSION FACTORS FOR AREA SOURCES

CAT	DESCRIPTION	EMISSION FACTOR
250	Synthetic Solvent Degreasing	2.23% of THC (1)
81	Other Organic Evaporation	0.0022 lb/capita/yr (2)
180	Consumer Products - Non Aerosol	0.0020 lb/capita/yr (3)
181	Consumer Products - Aerosol	0.0018 lb/capita/yr (4)

FOOTNOTES FOR TABLE:

(1) This factor assumes 95% of synthetic solvent emissions are TCA, and 1,4-dioxane is 2.35% by weight (3% by vol) of TCA.

(2) This factor was based on the TCA usage for adhesives, and assuming 1,4-dioxane is 0.78% by weight (1% by vol) of TCA.

(3) This factor was based on the TCA usage for miscellaneous sources, and assuming 1,4-dioxane is 0.78% by weight (1% by vol) of TCA.

(4) This factor was based on the TCA usage for aerosols, and assuming 1,4-dioxane is 0.78% by weight (1% by vol) of TCA.

C.5.2 MOBILE SOURCES

Mobile sources do not emit 1,4-dioxane, or the emissions are believed to be negligible.

REFERENCES:

Emissions of Potentially Toxic/Hazardous Air Contaminants in the South Coast Air Basin , SCAQMD, 1983.

Source Category Methodologies - Base Year 1982 Emissions Inventory, Bay Area Air Quality Management District, September 1983.

C.6 ETHYLENE DIBROMIDE (EDB)

C.6.1 AREA SOURCES

The primary use of EDB is as a lead scavenger in leaded gasoline. Area source categories of EDB include gasoline marketing and gasoline-fueled utility equipment. The use of EDB for pesticidal purposes has been sharply curtailed in recent years, and the current emissions from pesticide use is considered to be negligible.

The emission estimates were made by multiplying the annual THC emissions for a given category by an EDB species fraction. The species fractions were derived from data in CARBs Technical Support Document - Appendices to the Report on the Need for Controlling Airborne Ethylene Dibromide (1986). The factors used in calculating EDB emissions are summarized in the table below:

EDB SPECIES FRACTIONS FOR AREA SOURCES

CAT	DESCRIPTION	SPECIES FRACTION
Gasoline Combustion		
104	Domestic Reciprocating Engines	0.00482% of THC (1)
105	Gasoline-Fired Recip Eng. - Other	0.00243% of THC (2)
Gasoline Marketing		
52	Fuels Distribution - Trucking	0.00009% of THC (3)
53	Filling Stations - Spillage	0.00066% of THC (4)
54	Filling Stations - Storage Tanks	0.00009% of THC (3)
55	Filling Stations - Vehicle Tanks	0.00009% of THC (3)

FOOTNOTES FOR TABLE:

(1) This species fraction was derived from data in Table A-3 of the CARB EDB report (CARB, 1986) for utility equipment for the year 1987.

(2) This species fraction was derived from data in Table A-3 of the CARB EDB report for mobile equipment for the year 1987.

(3) This species fraction was derived from data in Table A-4 of the CARB EDB report for storage and transfer of motor gasoline for the year 1987. It was assumed that 20% of the total gasoline usage was leaded gasoline.

(4) This species fraction was derived from data in Table A-4 of the CARB EDB report for spillage of motor gasoline for the year 1987. It was assumed that 20% of the total gasoline usage was leaded gasoline.

C.6.2 MOBILE SOURCES

The EDB emissions for on-road mobile sources were based on species fractions derived from data in the CARB EDB report for leaded-gasoline fueled vehicles for the year 1987. The species fractions used are given below:

EDB SPECIES FRACTIONS FOR MOBILE SOURCES

Exhaust:	0.00139% of THC emissions
Evaporative:	0.00073% of THC emissions

THC exhaust and evaporative emission estimates by vehicle class and technology type were provided by CARB for the year 1987 for Contra Costa and Solano Counties. The EDB emissions were estimated by multiplying the species fractions by the CARB THC estimates for non-catalytic vehicles.

EDB emissions from off-road mobile sources were also estimated by using species fractions derived from data in the CARB EDB report. The species fractions used for off-road vehicles are listed as follows:

EDB SPECIES FRACTIONS FOR OFF-ROAD MOBILE SOURCES (% of THC)

CAT	DESCRIPTION	SPECIES FRACTION	
123	Farm Equipment, Gasoline	0.00243%	(1)
125	Construction Equip, Gasoline	0.00243%	(1)
137	Pleasure Boat, Gas 2-stroke	0.00214%	(2)
138	Pleasure Boat, Gas 4-stroke	0.00214%	(2)
144	General Aviation, Piston	0.05849%	(3)
146	Military Piston Aircraft	0.05849%	(3)
147	Agricultural Aircraft	0.05849%	(3)
166	Motorcycles, Off-road	0.00214%	(2)

FOOTNOTES FOR TABLE:

(1) This species fraction was derived from data in Table A-3 of the CARB EDB report for mobile equipment for the year 1987.

(2) This species fraction was derived from data in Table A-3 of the CARB EDB report for off-road vehicles for the year 1987.

(3) This species fraction was derived from data in Table A-3 of the CARB EDB report for aircraft for the year 1987.

REFERENCE:

Technical Support Document - Appendices to the Report on the Need for Controlling Airborne Ethylene Dibromide, CARB, September, 1986.

C.7 ETHYLENE OXIDE

C.7.1 AREA SOURCES

Emissions of ethylene oxide are largely associated with hospital sterilizers, which are treated as point sources. The only potential area source use of ethylene oxide may be as a fumigant. Ethylene oxide emissions from fumigant use could not be quantified, but are thought to be relatively minor.

C.7.2 MOBILE SOURCES

Mobile sources do not emit ethylene oxide, or the emissions are believed to be negligible.

REFERENCE:

Locating and Estimating Air Emissions from Sources of Ethylene Oxide, EPA, Sept. 1986.

C.8 FORMALDEHYDE

C.8.1 AREA SOURCES

Area source categories of formaldehyde emissions include fuel combustion and waste burning, consumer products use, photographic film developing, and electroplating. Although not considered in this study, formation of formaldehyde by photo oxidation of VOCs is believed to be the largest single source of formaldehyde in the atmosphere (Linnard, et al., 1982).

Formaldehyde emission estimates for fuel combustion and waste burning categories were made using emission factors or THC species fractions derived from data in EPAs Locating and Estimating Air Emissions from Sources of Formaldehyde (1984). Emission estimates for consumer products use, film developing and "electroless" plating operations were based on "per capita" factors derived from data in the SCAQMDs Emissions of Potentially Toxic/Hazardous Air Contaminants in the South Coast Air Basin (1983). For categories with point and area source components, the area source emissions were taken to be the total county emissions minus the emissions from point sources in that category. The factors used in calculating formaldehyde emissions for area sources are summarized in the table below:

FORMALDEHYDE EMISSION FACTORS FOR AREA SOURCES

CAT	DESCRIPTION	SPECIES FRACTION/EMISSION FACTOR
Fuel Combustion		
85	Domestic Wood Combustion	3.0 lb/ton-wood (1)
83	Domestic Gas Combustion	0.0010 lb/1000 scf (2)
84	Domestic Fuel Oil Combustion	0.0325 lb/1000 gal (3)
86	Commercial/Inst Gas Combustion	0.0002 lb/1000 scf (4)
87	Commercial/Inst Fuel Oil Comb.	0.0325 lb/1000 gal (3)
111	Natural Gas Combustion - Other	0.0001 lb/1000 scf (5)
104	Domestic Reciprocating Engines	1.20% of THC (6)
107	Oil-Fired Reciprocating Engines	2.20% of THC (7)
105	Gasoline-Fired Recip Eng.- Other	1.40% of THC (8)
Waste Burning		
120	Agricultural Debris Burning	24.70% of THC (9)
170	Accidental Fires - Vegetation	24.70% of THC (9)
265	Incineration	16.60% of THC (10)
Evaporative Emission Sources		
180	Consumer Prod. - Non Aerosol	0.013 lb/capita/yr (11)
81	Other Organics Evaporation	0.010 lb/capita/yr (12)

FOOTNOTES FOR TABLE:

(1) This emission factor is reported for wood combustion in fireplaces in an EPA Emission Factor Compilation (EPA, 1987).

(2) This emission factor (converted from 0.43 ng/J) was reported in Table 17 of the EPA formaldehyde locator document (EPA, 1984) for domestic natural gas-fired sources.

(3) This emission factor (converted from 0.10 ng/J) was reported in Table 17 of the EPA formaldehyde locator document for distillate oil-fired sources.

(4) This emission factor (converted from 0.095 ng/J) was reported in Table 17 of the EPA formaldehyde locator document for commercial/institutional gas-fired sources.

(5) This emission factor (converted from 0.43 ng/J) was reported in Table 17 of the EPA formaldehyde locator document for industrial gas-fired sources.

(6) This species fraction was derived from the formaldehyde emission factor reported in Table 20 of the EPA locator document for 4-stroke motorcycles (1.4 g/gal) and the THC emission factor for this source category given in the BAAQMDs Source Inventory Methodology (264 lb/gal).

(7) This species fraction was derived from the formaldehyde emission factor reported in Table 18 of the EPA locator document for diesel powered industrial equipment (0.15 g/hp-hr) and the THC emission factor given in AP-42 for this source category (6.68 g/hp-hr).

(8) The THC species fraction derived for non-catalytic light duty vehicles (see mobile source section) was used to estimate formaldehyde emissions from this category.

(9) This species fraction was derived from the average formaldehyde emission factor reported in Table 18 of the EPA locator document for backyard burning (5.4 g/kg) and the average THC emission factor for leaf burning given in AP-42 (40 lb/ton).

(10) This species fraction was derived from the average formaldehyde emission factor reported in Table 18 of the EPA locator document for apartment incinerators (2.5 g/kg) and the THC emission factor for industrial/commercial single chamber incinerators given in AP-42 (15 lb/ton).

FOOTNOTES FOR TABLE (CONT.):

(11) This emission factor was derived from information in the SCAQMD report (1983) for formaldehyde emissions from bacteria inhibitors in domestic chemicals. The factor assumes an average formaldehyde content of 0.6% of VOC, and an annual VOC usage of 1.1 tons/1000 persons.

(12) This emission factor was derived from data in the SCAQMD report for formaldehyde emissions from photographic film developing and electroless copper plating. The "per capita" factor was calculated as the total emissions from these two categories in the SCAQMD region divided by the population.

C.8.2 MOBILE SOURCES

The formaldehyde emissions for on-road mobile sources were based on emission factors given in Table 20 of the EPA locator document. These emission factors are expressed in units of grams of formaldehyde emitted per gallon of fuel burned based on vehicle class and pollution control technology type. For catalyst equipped autos, a range of emissions is given. The lower end of the range represents the emissions from newer, low-mileage cars and the higher end represents the emissions from high mileage cars. A VMT-weighted average factor was derived for catalyst equipped LDVs assuming the lower-end factor applies to 1987 and 1988 vehicle models and the upper-end factor applies to 1975 and older vehicles, with a linear degradation of emissions for model years in between.

A gram per vehicle mile traveled (VMT) factor was calculated for each vehicle class and pollution control technology type (i.e. catalyst, non-catalyst and diesel) from the gram per gallon values based on average fuel economy estimates derived from recent CARB data. Because emission data was not available for medium duty vehicles (MDVs), the emission factors for MDVs were based on the gram per gallon factors for automobiles, but with the fuel economy estimates for MDVs. The derived formaldehyde emission factors are given in the table below:

FORMALDEHYDE EMISSION FACTORS FOR MOBILE SOURCES (G/MI)

LDVs			MDVs		HDVs (gas)		HDVs	Motor-
n	c	d	n	c	n	c	diesel	cycles
0.052	0.020	0.021	0.075	0.030	0.112	0.045	0.100	0.026

n = non-catalyst, c = catalyst, d = diesel

VMT estimates by vehicle class and technology type were provided by CARB for the year 1987 for Contra Costa and Solano Counties. The emissions of formaldehyde were estimated by multiplying the derived emission factors by the CARB VMT estimates.

Formaldehyde emissions from off-road mobile sources were estimated by using species fractions most of which were derived from information given in the EPA locator document. The species fractions used for off-road vehicles are listed in the following table:

FORMALDEHYDE SPECIES FRACTIONS: OFF-ROAD MOBILE SOURCES (% of THC)

CAT	DESCRIPTION	SPECIES FRACTION	
123	Farm Equipment, Gasoline	3.22%	(1)
124	Farm Equipment, Diesel	12.00%	(1)
125	Construction Equip, Gas	2.85%	(2)
126	Construction Equip, Diesel	9.61%	(2)
135	Commercial Boats, Fishing	3.21%	(3)
136	Pleasure Boats, Diesel	6.13%	(4)
137	Pleas Boat, Gas 2-stroke	0.40%	(5)
138	Pleas Boat, Gas 4-stroke	1.52%	(6)
139	Locomotives	3.50%	(7)
143	General Aviation, Jet	1.40%	(8)
144	General Aviation, Piston	2.10%	(9)
145	Military Jet Aircraft	1.40%	(8)
146	Military Piston Aircraft	2.10%	(9)
147	Agricultural Aircraft	2.10%	(9)
192	Motorships, Cargo	3.21%	(3)
194	Motorships, Tankers	3.21%	(3)
166	Motorcycles, Off-road	0.40%	(5)

FOOTNOTES FOR TABLE:

(1) This species fraction was based on data in AP-42 for farm tractors assuming formaldehyde is 60% of total aldehyde emissions.

(2) This species fraction was based on data in AP-42 for wheeled construction tractors assuming formaldehyde is 60% of total aldehyde emissions.

(3) This species fraction was based on the emissions derived for heavy duty diesel trucks and the exhaust THC emissions for this category.

(4) This species fraction was based on the emissions derived for diesel LDVs and the exhaust THC emissions for this category.

FOOTNOTES FOR TABLE (CONT.):

(5) This species fraction was derived from the formaldehyde emission factor reported in Table 20 of the EPA locator document for 2-stroke motorcycles (3.3 g/gal) and the THC emission factor for this source category given in the BAAQMDs Source Inventory Methodology (1850 lb/gal).

(6) This species fraction was based on the emissions derived for non-catalyst LDVs and the exhaust THC emissions for this category.

(7) This species fraction was derived from the formaldehyde emission factor reported in Table 20 of the EPA locator document for locomotives (1.5 g/gal) and a THC emission factor for this source category given AP-42 (42.6 g/gal).

(8) This species fraction was derived from the formaldehyde emission factor reported in Table 20 of the EPA locator document for jet aircraft and a composite THC emission factor calculated from data in AP-42 for J-57 engines.

(9) This species fraction was derived from the formaldehyde emission factor reported in Table 20 of the EPA locator document for piston aircraft and a composite THC emission factor calculated from data in AP-42 for O-320 piston engines.

REFERENCES:

Compilation of Air Pollutant Emission Factors, AP-42, EPA, September 1985.

Emissions of Potentially Toxic/Hazardous Air Contaminants in the South Coast Air Basin , SCAQMD, 1983.

Linnard, H., et al., Potentially Toxic Substances Preliminary Inventory, CARB, November, 1982.

Locating and Estimating Air Emissions from Sources of Formaldehyde, EPA, March, 1984.

Preliminary Compilation of Air Pollutant Emission Factors For Selected Air Toxic Compounds, EPA-450/4-86-010a, April 1987.

Source Category Methodologies - Base Year 1982 Emissions Inventory, Bay Area Air Quality Management District, September 1983.

C.9 PERCHLOROETHYLENE

C.9.1 AREA SOURCES

The predominant use of perchloroethylene (PCE) is as a solvent in dry cleaning operations. PCE is also used as a solvent in metal cleaning/degreasing operations, and as a constituent in aerosol spray cans, adhesives, and coatings which are largely consumer products. Most of the PCE emission estimates were made using information in EPAs Survey of Perchloroethylene Emission Sources (1985).

The BAAQMD regulates all dry cleaners with an annual net solvent usage of 320 gallons or more. PCE emission estimates for regulated dry cleaners were based on solvent usage information reported to the BAAQMD from these facilities. Most of these regulated facilities were treated as point sources. The PCE emissions from exempt dry cleaners were based on an assumed average net solvent usage of 300 gallons/yr per facility. The number of exempt facilities was estimated by subtracting the number of regulated facilities in a given county from the total number of dry cleaners reported for that county in a Bureau of the Census document (1987).

Emission estimates of PCE from metal cleaning/degreasing operations were based on emission estimates given for the State of California for the year 1983 in the EPA survey document. The PCE emissions for Contra Costa and Solano Counties were estimated by assuming that emissions are proportional to the number of employees in the five primary industry groups that have been reported to use solvent degreasing operations. These industry groups are furniture and fixtures (SIC 25), fabricated metal products (SIC 34), electric and electronic equipment (SIC 36), transportation equipment (SIC 37), and miscellaneous manufacturing industries (SIC 39). County employment data by SIC category for the year 1985 (the most recent year available) was taken from a Bureau of the Census document (1987).

PCE emissions from miscellaneous sources such as aerosol spray cans, adhesives, and coatings were based on national PCE consumption information given in the EPA survey document. The PCE emissions for Contra Costa and Solano Counties were estimated by assuming that emissions from these categories are proportional to population. It was assumed that all of the PCE used in these applications, which are largely consumer products, is eventually emitted to the atmosphere.

For categories with point and area source components, the area source emissions were taken to be the total county emissions minus the emissions for point sources in that category. The factors used in calculating PCE emissions from area sources are summarized in the table on the next page:

PERCHLOROETHYLENE EMISSION FACTORS FOR AREA SOURCES

CAT	DESCRIPTION	EMISSION FACTOR
71	Dry Cleaning - Perc	2.02 ton/yr/exempt plant(1)
251	Solvent Degreasing - Mfg	0.81 lb/employee/yr (2)
252	Solvent Deg. - Ind. Maint.	1.70 lb/employee/yr (3)
253	Solvent Deg. - Com. Maint.	7.91 lb/employee/yr (4)
180	Consumer Prod.- Non Aerosol	0.16 lb/capita/yr (5)
181	Consumer Prod. - Aerosol	0.02 lb/capita/yr (6)

FOOTNOTES FOR TABLE:

(1) This factor (for exempt dry cleaners) was based on an assumed net PCE usage of 300 gal/yr.

(2) An emission factor of 10.42 lb/employee/yr was calculated for all degreasing operations as the annual PCE emissions in California (from the EPA survey document) divided by the total number of employees in five industry groups. The emission factor for degreasing category #251 was calculated by multiplying this factor by the fraction of THC emissions in this category (7.8%).

(3) The emission factor for degreasing category #252 was calculated by multiplying the factor derived for all degreasing operations (10.42 lb/employee/yr) by the fraction of THC emissions in this category (16.3%).

(4) The emission factor for degreasing category #253 was calculated by multiplying the factor for all degreasing operations (10.42 lb/employee/yr) by the fraction of THC emissions in this category (75.9%).

(5) This factor was based on national PCE usage estimates given in the EPA survey document for all miscellaneous uses other than aerosols.

(7) This factor was based on national PCE usage estimates given in the EPA survey document for aerosols.

C.9.2 MOBILE SOURCES

Mobile sources do not emit PCE, or the emissions are believed to be negligible.

REFERENCES:

County Business Patterns 1985, Bureau of the Census, U.S. Department of Commerce, August 1987.

Survey of Perchloroethylene Emission Sources, EPA-450/3-85-017, June 1985.

C.10 PHENOL

C.10.1 AREA SOURCES

Emissions of phenol are largely associated with activities at chemical plants, which are treated as point sources. There is very little information in the literature regarding phenol emissions from area sources. Emission estimates for residential fireplaces were made using the emission factor given in the table below. Annual wood use estimates for fireplaces were made according to the procedure described in the BAAQMDs Source Category Methodologies (1983).

PHENOL EMISSION FACTOR FOR AREA SOURCES

CAT	DESCRIPTION	EMISSION FACTOR
85.	Domestic Wood Combustion	2.0 lb/ton-wood (1)

FOOTNOTE FOR TABLE:

(1) This emission factor was taken from an EPA emission factor compilation (EPA, 1987)

C.10.2 MOBILE SOURCES

Emission estimates of phenol from mobile sources were not made due to insufficient emission information.

REFERENCES:

Preliminary Compilation of Air Pollutant Emission Factors for Selected Air Toxic Compounds, EPA-450/4-86-010a, April 1987.

Source Category Methodologies - Base Year 1982 Emissions Inventory, Bay Area Air Quality Management District, September 1983.

C.11 TRICHLOROETHYLENE (TCE)

C.11.1 AREA SOURCES

Although TCE has been used extensively in the past in cleaning/degreasing operations, the use of this solvent has greatly diminished in recent years. Degreasing operations remain the only significant area source category of TCE emissions at this time.

Emission estimates of TCE from metal cleaning/degreasing operations were based on information on synthetic solvent degreasing given in the BAAQMDs Source Category Methodologies (1983). Synthetic solvent degreasing involves the use of both TCE and trichloroethane (TCA) solvents. A solvent survey conducted for CARB in 1976 indicated that TCE use accounted for about 12% of the total synthetic solvent used for degreasing. TCE has gradually been replaced by TCA as a degreasing solvent, at a rate of about 6% per year (SCAQMD, 1983). From this information, 1987 TCE use was estimated to be 5% of the total synthetic solvent used for degreasing. TCE emissions were estimated by multiplying the 1987 THC emissions for synthetic solvent degreasing by a species fraction of 0.05 (5.0%).

Area source emissions were taken to be the total county TCE emissions from degreasing operations minus the emissions for point sources in this category. The factor used in calculating TCE emissions from area sources is summarized as follows:

TCE SPECIES FRACTION FOR AREA SOURCES

CAT	DESCRIPTION	SPECIES FRACTION
250	Synthetic Solvent Degreasing	5.00% of THC

C.11.2 MOBILE SOURCES

Mobile sources do not emit TCE, or the emissions are believed to be negligible.

REFERENCES:

Emissions of Potentially Toxic/Hazardous Air Contaminants in the South Coast Air Basin , SCAQMD, 1983.

Source Category Methodologies - Base Year 1982 Emissions Inventory, Bay Area Air Quality Management District, September 1983.

C.12 VINYL CHLORIDE

C.12.1 AREA SOURCES

Emissions of vinyl chloride are largely associated with activities at chemical plants, which are treated as point sources. There is very little information in the literature regarding vinyl chloride emissions from area sources, although landfills and incineration have been identified as potentially significant source categories (SCAQMD, 1983). Additional studies and testing are needed to better define vinyl chloride emissions from area sources before emissions estimates can be made.

C.12.2 MOBILE SOURCES

Emission estimates of vinyl chloride from mobile sources were not made due to insufficient emission information.

REFERENCE:

Emissions of Potentially Toxic/Hazardous Air Contaminants in the South Coast Air Basin, SCAQMD, September 1983.

C.13 ARSENIC (INORGANIC)

C.13.1 AREA SOURCES

Area source categories of inorganic arsenic include fuel oil combustion, and "fugitive" soil and road dust.

Emission information for arsenic from fuel oil combustion is available only for boilers. The same emission factor, given in the table below, was used for commercial boilers and residential furnaces. Arsenic emissions from industrial boilers were treated as point sources.

Arsenic is a natural component of most soils, typically present at levels of 1 to 50 ppmw (EPA, 1983). Preliminary calculations indicate that the arsenic emissions from "fugitive" sources such as resuspended road dust, and dust from construction and farming operations may far exceed the arsenic emissions from all other area source categories. There are, however, significant uncertainties in making emission estimates from fugitive dust sources. Arsenic emissions from fugitive dust sources were therefore not included in this study, although these sources may significantly contribute to ambient arsenic levels.

ARSENIC EMISSION FACTORS FOR AREA SOURCES

CAT	DESCRIPTION	EMISSION FACTOR
84	Domestic Fuel Oil Combustion	0.0154 lb/thou gal (1)
87	Commercial/Inst Fuel Oil Comb.	0.0154 lb/thou gal (1)

FOOTNOTE FOR TABLE:

(1) This factor (converted from 47.3 pg/J) was reported for combustion of distillate fuel oil in commercial boilers in an EPA emission factor compilation (EPA, 1987).

C.13.2 MOBILE SOURCES

Emission estimates of arsenic from mobile sources were not made due to insufficient emission information.

REFERENCES:

Hazardous Waste Land Treatment, EPA Office of Solid Waste and Emergency Response, SW-874, April, 1983.

Preliminary Compilation of Air Pollutant Emission Factors For Selected Air Toxic Compounds, EPA-450/4-86-010a, April 1987.

C.14 CADMIUM

C.14.1 AREA SOURCES

Area source categories of cadmium include fuels combustion, incineration and "fugitive" soil and road dust. Most of the information regarding cadmium emission sources was taken from EPAs Survey of Cadmium Emission Sources (1981).

The cadmium emission estimates for domestic and commercial fuel oil combustion were made by multiplying emission factors by annual county fuel use estimates. Cadmium emission estimates for other combustion sources were made by applying a species fraction to the total PM emissions.

Cadmium is a natural component of most soils, typically present at levels of 10 to 700 ppbw (EPA, 1983). Preliminary calculations indicate that the cadmium emissions from these "fugitive dust" sources may be quite significant. There are, however, large uncertainties in making emission estimates from fugitive dust sources. Cadmium emissions from fugitive dust sources were therefore not included in this study, although these sources may significantly contribute to total ambient cadmium levels.

For categories with point and area source components, the area source emissions were taken to be the total county cadmium emissions (calculated from total county fuel usage, or PM emissions) minus the emissions from point sources. The factors used in calculating cadmium emissions are summarized in the following table:

CADMIUM EMISSION FACTORS FOR AREA SOURCES

CAT	DESCRIPTION	EMISSION FACTOR/SPECIES FRACTION
84	Domestic Fuel Oil Comb.	1.45×10^{-3} lb/thou gal (1)
87	Comm./Inst Fuel Oil Comb.	1.45×10^{-3} lb/thou gal (1)
104	Domestic Reciprocating Eng.	0.020% of PM emissions (2)
105	Gasoline-Fired Eng., Other	0.020% of PM emissions (2)
107	Oil-Fired Recip. Engines	0.021% of PM emissions (3)
265	Incineration	0.030% of PM emissions (4)

FOOTNOTES FOR TABLE:

(1) This factor was reported for commercial/residential distillate oil combustion in the EPA Survey document (EPA, 1981).

(2) This PM species fraction was given for exhaust emissions from gasoline-fueled motor vehicles in a SCAQMD report (SCAQMD, 1987).

FOOTNOTES FOR TABLE (CONT.):

(3) This PM species fraction was reported for diesel motor vehicle exhaust in the SCAQMD document (1987).

(4) Most waste incineration in the Bay Area occurs in commercial units, but cadmium emission information is available only for municipal incinerators. The species fraction for incineration was taken to be 10% of the average factor reported for municipal incinerators in the EPA Survey document, because the cadmium content of commercial waste is expected to be significantly less than that of municipal waste.

C.14.2 MOBILE SOURCES

The cadmium emissions for on-road mobile sources were based on information in the SCAQMD document, The Magnitude of Ambient Air Toxics Impacts from Existing Sources in the South Coast Air Basin (1987). This document lists PM species fractions for catalytic, non-catalytic and diesel vehicles as follows:

CADMIUM SPECIES FRACTIONS FOR MOBILE SOURCES

Catalytic:	0.020% of exhaust PM
Non-Catalytic:	0.020% of exhaust PM
Diesel:	0.021% of exhaust PM

PM exhaust emission estimates by vehicle class and technology type were provided by CARB for the year 1987 for Contra Costa and Solano Counties. The cadmium emissions were estimated by multiplying the species fractions by the CARB PM estimates.

Cadmium emissions also result from vehicle tire wear. A factor of 1.9 micrograms per mile travelled, taken from a draft EPA Office of Mobile Sources report (1987), was used for tire wear. VMT estimates by vehicle class were provided by CARB for the year 1987 for Contra Costa and Solano Counties.

The cadmium emissions for most of the off-road mobile source categories were based on the same exhaust PM species fractions used for on-road mobile sources. The cadmium species fraction used for each off-road mobile source category is given in the table on the following page (only categories with PM emissions in Contra Costa and/or Solano County are listed).

CADMIUM SPECIES FRACTIONS FOR OFF-ROAD MOBILE SOURCES (% OF PM)

CAT	DESCRIPTION	SPECIES FRACTION
123	Farm Equipment, Gas	0.020% (1)
124	Farm Equipment, Diesel	0.021% (2)
125	Construction Equip, Gas	0.020% (1)
126	Construction Equip, Diesel	0.021% (2)
135	Commercial Boats, Fishing	0.021% (2)
136	Pleasure Boats, Diesel	0.021% (2)
137	Pleas Boat, Gas 2-stroke	0.020% (1)
139	Locomotives	0.021% (2)
143	General Aviation, Jet	0.010% (3)
144	General Aviation, Piston	0.020% (1)
145	Military Jet Aircraft	0.010% (3)
146	Military Piston Aircraft	0.020% (1)
192	Motorships, Cargo	0.021% (2)
194	Motorships, Tankers	0.021% (2)
166	Motorcycles, Off-road	0.020% (1)

FOOTNOTES FOR TABLE:

(1) The PM species fraction for gasoline-fueled motor vehicles from the SCAQMD report was used for this category.

(2) The PM species fraction for diesel motor vehicles from the SCAQMD report was used for this category.

(3) This species fraction was derived from the cadmium emission factor given in the EPA locator document for jet aircraft and a composite PM emission factor calculated from data in EPAs AP-42 for J-57 engines.

REFERENCES:

Compilation of Air Pollutant Emission Factors, AP-42, EPA, September, 1985.

Hazardous Waste Land Treatment, EPA Office of Solid Waste and Emergency Response, SW-874, April, 1983.

Mobile Source Air Toxics Information (draft), EPA Office of Mobile Sources, February, 1987.

Survey of Cadmium Emission Sources, EPA-450/3-81-013, September 1981.

The Magnitude of Ambient Air Toxics Impacts from Existing Sources in the South Coast Air Basin, SCAQMD, June 1987.

C.15 CHROMIUM

Chromium is an air contaminant that can be emitted in several different oxidation states, including the two biologically active forms, trivalent and hexavalent chromium. Hexavalent chromium has been identified as being a human carcinogen, and is the form of chromium of most interest as a TAC. Most of the historical emission data for chromium is, however, in terms of total chromium with the oxidation state not specified. Where possible, the chromium emission estimates made here are for hexavalent chromium.

C.15.1 AREA SOURCES

Area source categories of chromium include fuel oil combustion and waste burning, cooling towers, and "fugitive" soil and road dust. The available emission factors for combustion sources are for total chromium, but these emissions are thought to consist predominantly of trivalent chromium (CARB, 1985). The chromium emission estimates for domestic and commercial fuel oil combustion were made by multiplying emission factors by annual county fuel use estimates. Chromium emission estimates for other combustion sources were made by applying a species fraction to the total PM emissions.

The hexavalent chromium emissions from industrial cooling towers have been estimated for the State of California in CARBs Report to the Scientific Review Panel on Chromium (1985). The chromium emissions from industrial cooling towers in Contra Costa and Solano Counties were estimated from this State estimate by assuming that the emissions from these sources are proportional to population. It should be noted that the chromium emissions from comfort cooling towers were not estimated do to insufficient information.

Chromium is a natural component of most soils, and is present in higher concentrations in paved road dust. Preliminary calculations indicate that the chromium emissions from these "fugitive dust" sources may far exceed the emissions from all other area source categories. There are, however, significant uncertainties in making emission estimates from fugitive dust sources. Furthermore, available information suggests that chromium in soils exists in the trivalent form (CARB, 1985). Chromium emissions from fugitive dust sources were therefore not included in this study, although these sources may significantly contribute to total ambient chromium levels.

For categories with point and area source components, the area source emissions were taken to be the total county chromium emissions (calculated from total county fuel usage, or PM emissions) minus the emissions from point sources. The factors used in calculating chromium emissions are summarized in the table on the following page:

CHROMIUM EMISSION FACTORS FOR AREA SOURCES

CAT	DESCRIPTION	EMISSION FACTOR/SPECIES FRACTION
84	Domestic Fuel Oil Comb.	3.90×10^{-4} lb/thou gal (1)
87	Comm./Inst Fuel Oil Comb.	1.63×10^{-2} lb/thou gal (2)
107	Oil-Fired Recip. Engines	0.190% of PM emissions (3)
120	Agricultural Debris Burning	0.005% of PM emissions (4)
170	Accidental Fires - Veg.	0.005% of PM emissions (4)
265	Incineration	0.017% of PM emissions (5)

FOOTNOTES FOR TABLE:

(1) This factor (converted from 1.1 pg/J-heat input) was reported for combustion of distillate oil in residential boilers in an EPA emission factor compilation (EPA, 1987).

(2) This factor (converted from 50 pg/J-heat input) was reported for combustion of distillate oil in commercial boilers in an EPA emission factor compilation (EPA, 1987).

(3) This PM species fraction was reported for diesel motor vehicle exhaust in a SCAQMD document (SCAQMD, 1987).

(4) This PM species fraction was reported for agricultural field burning in an EPA receptor modeling document (EPA, 1984).

(5) This PM species fraction was the lower end of a range of values reported for refuse/sludge waste incineration in a CARB document (CARB, 1985).

C.15.2 MOBILE SOURCES

The chromium emissions ror on-road mobile sources were based on information in the SCAQMD document, The Magnitude of Ambient Air Toxics Impacts from Existing Sources in the South Coast Air Basin (1987). This document lists PM species fractions for catalytic, non-catalytic and diesel vehicles as follows:

CHROMIUM SPECIES FRACTIONS FOR MOBILE SOURCES

Catalytic:	0.001% of exhaust PM
Non-Catalytic:	0.001% of exhaust PM
Diesel:	0.190% of exhaust PM

PM exhaust emission estimates by vehicle class and technology type were provided by CARB for the year 1987 for Contra Costa and Solano Counties. The chromium emissions were estimated by multiplying the species fractions by the CARB PM estimates.

The chromium emissions for off-road mobile sources were based on the same PM species fractions used for on-road mobile sources. The chromium species fractions used for off-road mobile source categories are given below (only categories with PM emissions in Contra Costa and/or Solano County are listed):

CHROMIUM SPECIES FRACTIONS FOR OFF-ROAD MOBILE SOURCES (% OF PM)

CAT	DESCRIPTION	SPECIES FRACTION
123	Farm Equipment, Gas	0.001%
124	Farm Equipment, Diesel	0.190%
125	Construction Equip, Gas	0.001%
126	Construction Equip, Diesel	0.190%
135	Commercial Boats, Fishing	0.190%
136	Pleasure Boats, Diesel	0.190%
137	Pleas Boat, Gas 2-stroke	0.001%
139	Locomotives	0.190%
144	General Aviation, Piston	0.001%
146	Military Piston Aircraft	0.001%
166	Motorcycles, Off-road	0.001%

REFERENCES:

Preliminary Compilation of Air Pollutant Emission Factors For Selected Air Toxic Compounds, EPA-450/4-86-010a, April 1987.

Receptor Model Source Composition Library, EPA-450/4-85-002, November 1984.

Report to the Scientific Review Panel on Chromium, CARB, 1985.

The Magnitude of Ambient Air Toxics Impacts from Existing Sources in the South Coast Air Basin, SCAQMD, June 1987.

C.16 POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)

The PAHs are a category of organic compounds that consist of carbon and hydrogen atoms structured in two or more fused aromatic rings. The PAHs include such compounds as naphthalene, phenanthrene, anthracene, fluoranthene, chrysene, the benzpyrenes, and coronene. The PAHs and the PAH-nitrogen analogs (e.g. nitrochrysene) are the most common types of polycyclic organic matter (POM) emitted as air contaminants.

Information regarding the emissions of PAHs varies considerably with respect to the specific PAH compounds analyzed. One emission factor may be based on a source test that analyzed for 10 specific PAH compounds, while another emission factor may be based on an analysis of 20 PAH compounds. The total PAH emissions calculated for different types of sources may therefore not be directly comparable.

C.16.1 AREA SOURCES

Some of the PAH emission estimates for area sources were made by multiplying source-category-specific emission factors taken from the literature by total annual county fuel use estimates. The fuel use estimates for Contra Costa and Solano Counties were made using the procedures described in the BAAQMDs Source Category Methodologies (1983). Where specific emission factors were not available for a given source category, a species fraction was applied to the total THC or PM emissions from that category to estimate PAH emissions. For categories with point and area source components, the area source emissions were taken to be the total county PAH emissions (calculated from total county fuel usage, or THC or PM emissions) minus the emissions from point sources. The factors used in calculating PAH emissions are summarized in the table below:

PAH EMISSION FACTORS FOR AREA SOURCES

CAT	DESCRIPTION	EMISSION FACTOR/SPECIES FRACTION
85	Domestic Wood Combustion	0.068 lb/ton-wood (1)
83	Domestic Gas Combustion	8.05×10^{-7} lb/thou scf (2)
84	Domestic Fuel Oil Comb.	3.35×10^{-3} lb/thou gal (3)
86	Commercial/Inst Gas Comb.	3.40×10^{-5} lb/thou scf (4)
87	Comm./Inst Fuel Oil Comb.	6.50×10^{-3} lb/thou gal (5)
111	Natural Gas Comb. - Other	3.40×10^{-5} lb/thou scf (4)
104	Domestic Recip. Engines	0.03% of THC emissions (6)
107	Oil-Fired Recip. Engines	0.55% of THC emissions (7)
105	Gas-Fired Recip Eng.- Other	0.07% of THC emissions (8)
120	Agricultural Debris Burning	0.03% of PM emissions (9)
170	Accidental Fires - Veg.	0.05% of PM emissions (10)
265	Incineration	0.029 lb/ton-waste (11)

FOOTNOTES FOR TABLE:

(1) This factor is a weighted average of two values given in an EPA emission factor compilation (EPA, 1987) for fireplaces and woodstoves (wood use was assumed to be 98% for fireplaces and 2% for woodstoves). The factor for fireplaces is in agreement with two factors reported for burning seasoned oak in fireplaces by Hartman, et al. (1985). The most predominant PAHs emitted from wood combustion are anthracene, phenanthrene, fluoranthene, and methyl anthracenes/phenanthrenes.

(2) This factor (converted from 0.33 pg/J-heat input) was reported for a natural gas fired residential hot air heater by Hangebrauck, et al. (1967). Of the ten specific POM compounds analyzed for, about 90% were pyrene, fluoranthene and phenanthrene.

(3) This factor (converted from 10.3 pg/J-heat input) was taken from an EPA emission factor compilation (EPA, 1987), and is approximately equal to the average of 2 factors for oil-fired domestic hot air furnaces reported by Hangebrauck, et al. (1964). This reference reports that between 50 and 90 percent of the total PAHs emitted are fluoranthene.

(4) This factor (converted from 13.8 pg/J-heat input) is the average of two values given by Hangebrauck, et al. (1967) for boilers used for process or space heating. This reference indicated that pyrene and fluoranthene constituted in excess of 70% of the total PAHs measured.

(5) This factor (converted from 20.0 pg/J-heat input) was reported in an EPA emission factor compilation (EPA, 1987) for tangential-fired commercial boilers burning distillate oil.

(6) PAH emissions from domestic gasoline-fueled reciprocating engines (primarily lawnmowers) were estimated by multiplying the 1987 THC emissions for this source category by the PAH species fraction derived for motorcycles (see mobile source section).

(7) The THC species fraction derived for light duty diesel passenger vehicles (see mobile source section) was used to estimate PAH emissions from this category.

(8) The THC species fraction derived for non-catalytic light duty gasoline-fueled passenger vehicles (see mobile source section) was used to estimate PAH emissions from this category.

FOOTNOTES FOR TABLE (CONT.):

(9) This species fraction was a value for open burning of landscaping refuse reported by Hangebrauck, et al. (1967). Of the ten PAH compounds measured, 80% was reported to be pyrene and fluoranthene.

(10) This species fraction is the average of three values for burning pine needles in heading fires reported by McMahon et al. (1977). Anthracene, phenanthrene, methyl anthracene, fluoranthene, and pyrene were listed as the most prevalent PAH compounds emitted.

(11) This factor is the average of two values given for commercial solid waste incinerators reported by Hangebrauck, et al. (1967). Pyrene, benzo(g,h,i)perylene and fluoranthene were the most prevalent PAH compounds emitted.

C.16.2 MOBILE SOURCES

The PAH emission factors for on-road mobile sources were based on data from the Committee on Pyrene and Selected Analogues (1983). Emission factors in this document are expressed in units of micrograms per gallon of fuel burned for a comprehensive set of 26 PAH compounds based on vehicle class and pollution control technology type. The PAH emission factors given for light-duty vehicles (LDVs) with catalysts represent reductions from the pre-controlled levels of about 80% for LDVs with oxidation catalysts and about 98% for LDVs with 3-way catalysts. These control efficiencies are in agreement with results reported in other studies (Cadle et al. (1979), for example).

A microgram per vehicle mile traveled (VMT) emission factor was calculated for each vehicle class and technology type (i.e catalyst, non-catalyst, and diesel) from the microgram per gallon values based on average fuel economy estimates derived from recent CARB data. A VMT-weighted emission factor was derived for LDVs with catalysts based on an estimate of the percent of VMT attributable to LDVs with 3-way catalysts (73%) versus oxidation catalysts (27%) for the year 1987. The catalyst technology data was provided by CARBs Mobile Source Division (1987). Total PAH emission factors were calculated based on the sum of the 26 individual PAH compounds given. Nearly 50 percent of the total PAHs consisted of the lighter-weight PAHs anthracene, phenanthene and some alkyl derivatives of phenanthene. Emission factors for benzo(a)pyrene (B(a)P) were also calculated since B(a)P exposure estimates may be of interest (the B(a)P factors are 0.67 percent of the total PAH factors). The derived PAH emission factors are given in the table on the following page:

PAH EMISSION FACTORS FOR ON-ROAD MOBILE SOURCES (UG/MI)

	LDVs			MDVs		HDVs (gas)		HDVs diesel	Motor-cycles
	n	c	d	n	c	n	c		
Total PAHs	2507	113	2059	3670	246	7147	1328	8713	761
B(a)P	16.8	.76	13.8	24.6	1.7	47.9	8.90	58.4	5.10

n = non-catalyst, c = catalyst, d = diesel

VMT estimates by vehicle class and technology type were provided by CARB for the year 1987 for Contra Costa and Solano Counties. The emissions of PAHs were estimated by multiplying the derived emission factors by the CARB VMT estimates. The emissions of B(a)P are a constant percentage (0.67 percent) of the total PAH emissions.

Composite emission factors were derived from the information listed above for the 1987 fleet of on-road vehicles. The total PAH composite emission factor is 943 ug/mi and the B(a)P composite emission factor is 6.3 ug/mi. A somewhat higher composite B(a)P emission factor (16.6 ug/mi) for on-road mobile sources was used in the EPAs Six Month Study (1985). The lower composite emission factor derived here may be due in part to a higher percentage of vehicles having 3-way catalysts in California versus the national average, and a higher percentage of vehicles with 3-way catalysts in the more recent vehicle fleet.

The PAH emission estimates for off-road mobile sources were estimated from species fractions calculated from the on-road vehicle PAH estimates. The species fractions were taken to be the total PAH emissions calculated for a given vehicle category divided by tne total exhaust hydrocarbon emissions from that category. The THC emissions used to calculate the species fractions were recent estimates made by CARB for on-road vehicles in Contra Costa and Solano Counties using EMFAC7C emission factors and accounting for the vehicle I/M program.

The PAH emissions for a given off-road vehicle category were calculated as the product of the THC emissions for that category and the derived species fraction of the most closely resembled on-road vehicle category. The PAH species fractions used for off-road mobile source categories are given in the table on the next page (only categories with THC emissions in Contra Costa and/or Solano County are listed):

PAH SPECIES FRACTIONS FOR OFF-ROAD MOBILE SOURCES (% of THC)

CAT	DESCRIPTION	SPECIES FRACTION	ON-ROAD CATEGORY DERIVED FROM
123	Farm Equipment, Gas	0.11%	non-catalyst gas MDVs
124	Farm Equipment, Diesel	0.28%	HD diesel trucks
125	Construct. Equip, Gas	0.11%	non-catalyst gas MDVs
126	Construct. Equip, Diesel	0.28%	HD diesel trucks
135	Commerc. Boats, Fishing	0.28%	HD diesel trucks
136	Pleasure Boats, Diesel	0.55%	LD diesel autos
137	Pleas Boat, Gas 2-stroke	0.03%	motorcycles
138	Pleas Boat, Gas 4-stroke	0.07%	non-catalyst LD autos
139	Locomotives	0.28%	HD diesel trucks
143	General Aviation, Jet	0.04%	catalyst gas MDVs (1)
144	General Aviation, Piston	0.07%	non-catalyst LD autos
145	Military Jet Aircraft	0.04%	catalyst gas MDVs (1)
146	Military Piston Aircraft	0.08%	non-catalyst LD trucks
147	Agricultural Aircraft	0.07%	non-catalytic LD autos
192	Motorships, Cargo	0.28%	HD diesel trucks
194	Motorships, Tankers	0.28%	HD diesel trucks
166	Motorcycles, Off-road	0.03%	Motorcycles

FOOTNOTE FOR TABLE:

(1) PAH emission factors for aircraft turbine engines were not available. Robertson, et al. (1980) reports that the majority of PAHs in gas turbine engines are smaller 3- and 4-fused ring compounds. Due to the much higher air/fuel ratios that turbine engines operate at in comparison to piston engines, more complete combustion and a lower PAH species fraction is expected. A species fraction of 0.04% of THC (the species fraction for catalytic MDVs) was assumed for jet aircraft.

REFERENCES:

Cadle et al., "Measurement of Unregulated Emissions From General Motors Light Duty Vehicles," Society of Automotive Engineers Paper No. 790694, Warrendale, PA, 1979.

CARB Mobile Source Division, Personal Communication with Philip Heirigs, August 1987.

Hangebrauck, R.P., et al., "Emissions of Polynuclear Hydrocarbons and Other Pollutants from Heat Generation and Incineration Processes", Journal of the Air Pollution Control Association, July 1964.

REFERENCES (CONT.):

Hangebrauck, R.P., et al., "Sources of Polynuclear Hydrocarbons in the Atmosphere", Public Health Service Report No. AP-33, 1967

Hartman, M.W., et al., Literature Review and Survey of Emissions from Residential Wood Combustion and Their Impact, EPA 660/2-85-047, April 1985.

McMahon, C.K., et al., "Polynuclear Aromatic Hydrocarbons in Forest Fire Smoke", Proceedings of the Second International Symposium on Polynuclear Aromatic Hydrocarbons, Columbus, Ohio, 1977.

Polycyclic Aromatic Hydrocarbons: Evaluation of Sources and Effects, Committee on Pyrene and Selected Analogues, Board on Toxicology and Environmental Health Hazards, Commission on Life Sciences, National Research Council. National Academy Press, Washington, D.C., 1983.

Preliminary Compilation of Air Pollutant Emission Factors For Selected Air Toxic Compounds, EPA-450/4-86-010a, April 1987.

Robertson, D.J., et al., "Organic Content of Particulate Matter in Turbine Engine Exhaust", Journal of the Air Pollution Control Association, March 1980.

Source Category Methodologies - Base Year 1982 Emissions Inventory, Bay Area Air Quality Management District, September 1983.

The Air Toxics Problem in the United States: An Analysis of Cancer Risks for Selected Pollutants, EPA, May 1985.

APPENDIX D

TOXIC AIR CONTAMINANT AREA SOURCE DISAGGREGATION FACTORS

D. AREA SOURCE DISAGGREGATION FACTORS

The factors in the table below indicate the percent of the total emissions for each source category disaggregated by the eight ABAG population and employment distributions.

RESIDENTIAL
1 - Population
2 - Households

EMPLOYMENT
3 - Agriculture, Forest, Mining
4 - Manufacturing
5 - Wholesale
6 - Retail
7 - Service
8 - Other

CAT	DESCRIPTION	1	2	3	4	5	6	7	8
19	Other Chemicals Mfg	0	0	0	100	0	0	0	0
21	Photoresist	0	0	0	100	0	0	0	0
23	Metallurgical	0	0	0	100	0	0	0	0
24	Asphaltic Concrete Plants	0	0	0	100	0	0	0	0
25	Concrete Batching	0	0	0	100	0	0	0	0
26	Glass Products Mfg	0	0	0	100	0	0	0	0
27	Stone, Sand and Gravel	0	0	100	0	0	0	0	0
28	Sand Blasting	0	20	0	30	0	0	10	40
29	Cement Mfg	0	0	0	100	0	0	0	0
30	Salt	0	0	0	100	0	0	0	0
31	Food Preparation	0	0	0	0	20	60	20	0
32	Bakeries (Industrial)	0	0	0	80	10	10	0	0
33	Wineries, Breweries	0	0	100	0	0	0	0	0
34	Other Agric. Processing	0	0	20	80	0	0	0	0
35	Farming Operations	0	0	100	0	0	0	0	0
38	Construction Operations	0	60	0	10	10	10	0	10
41	Wood Products Mfg	0	20	0	20	20	20	10	10
42	Land Farming	0	0	0	100	0	0	0	0
43	Gas Distribution	0	50	0	10	10	10	0	20
44	Other Industrial/Commerc.	0	0	10	50	10	0	10	20
50	Bulk Plants- Storage Tank	0	0	0	0	100	0	0	0
51	- Loading Trucks	0	0	0	0	100	0	0	0
52	Trucking	0	0	10	20	20	40	10	0
53	Filling Stations - Spill.	0	0	5	5	5	75	5	5
54	- Storage Tanks	0	0	5	5	5	75	5	5
55	- Filling Vehicles	0	0	5	5	5	75	5	5
57	Storage Tanks - Solvents	0	0	0	90	0	0	10	0
58	- Other Organic Cmpds.	0	0	0	90	0	0	10	0
65	- Thinning & Cleanup	0	50	5	10	5	10	10	10
66	Coatings Mfg	0	0	0	100	0	0	0	0
67	Asphalt Paving	100	0	0	0	0	0	0	0
71	Dry Cleaners - Perc	0	0	0	0	0	0	100	0
72	- Other Solvents	0	0	0	0	0	0	100	0
73	Fiberglass Products Mfg	0	0	0	100	0	0	0	0
74	Rubber/Plastic Prod. Mfg	0	0	0	100	0	0	0	0

(CONTINUED)

AREA SOURCE DISAGGREGATION FACTORS (CONT.)

CAT	DESCRIPTION	1	2	3	4	5	6	7	8
75	Printing - Rotogravure	0	0	0	100	0	0	0	0
76	- Flexographic	0	0	0	100	0	0	0	0
77	- Other Printing	0	0	0	80	0	0	0	20
78	Pharmaceuticals Mfg	0	0	0	100	0	0	0	0
81	Other Organics Evaporation	0	0	0	80	0	0	10	10
83	Domestic - Gas	0	100	0	0	0	0	0	0
84	- Liquid	0	100	0	0	0	0	0	0
85	- Solid	0	100	0	0	0	0	0	0
86	Commercial & Instit.- Gas	0	0	0	0	30	30	30	10
87	- Oil	0	0	0	0	30	30	30	10
104	Recip Engs - Gas. Domest.	0	100	0	0	0	0	0	0
105	- All Other Gasoline	0	0	20	30	5	10	30	5
106	- Gas Fueled	0	0	0	90	0	0	0	10
107	- Oil Fueled	0	0	20	30	10	10	20	10
108	Orchard Heaters	0	0	100	0	0	0	0	0
109	Cogeneration	0	0	0	80	0	0	0	20
111	Other Combustion - NG	0	0	0	80	0	0	0	20
112	- Oil	0	0	0	80	0	0	0	20
113	- LPG	0	0	0	80	0	0	0	20
114	- Coke, Coal	0	0	0	100	0	0	0	0
115	- Other Fuels	0	0	0	80	0	0	0	20
120	Agric. Debris Burning	0	0	100	0	0	0	0	0
121	Range/Forest Imp. Burning	0	0	100	0	0	0	0	0
122	Resource Recovery	0	0	0	0	0	0	0	100
123	Farm Equipment - Gas	0	0	100	0	0	0	0	0
124	- Diesel	0	0	100	0	0	0	0	0
125	Construct. Equip. - Gas	0	20	20	10	10	20	10	10
126	- Diesel	0	20	20	10	10	20	10	10
139	Locomotives	40	0	30	30	0	0	0	0
147	Agricultural Aircraft	0	0	100	0	0	0	0	0
166	Motorcycles-off-road	0	0	100	0	0	0	0	0
167	- 4 Stroke	0	0	100	0	0	0	0	0
169	Accidental Fires - Struct.	0	50	0	10	5	10	10	15
170	- Vegetation	0	0	100	0	0	0	0	0
171	- Other	0	40	10	20	5	10	10	5
172	Roads, Paved	50	0	10	10	10	10	5	5
173	- Vehicle Travel, Unpaved	0	0	90	10	0	0	0	0
174	Vegetation	0	10	80	0	0	0	0	10
175	Bio degradation	0	20	40	20	0	0	0	20
180	Consumer Prod.- Non Aero.	80	0	0	5	0	5	5	5
181	- Aerosol Product Only	80	0	0	5	0	5	5	5
182	- Aerosol Propellents	80	0	0	5	0	5	5	5
217	Pesticides - Synth	0	0	100	0	0	0	0	0
218	- Non Synthetic	0	0	100	0	0	0	0	0
219	Creosote Application	0	20	20	10	10	20	10	10
221	Oil Production Fields	0	0	100	0	0	0	0	0
222	Gas Production Fields	0	0	100	0	0	0	0	0
230	Struct. Coating - Oil Base	0	50	5	10	5	10	10	10
231	- Water Base	0	50	5	10	5	10	10	10

(CONTINUED)

AREA SOURCE DISAGGREGATION FACTORS (CONT.)

CAT	DESCRIPTION	1	2	3	4	5	6	7	8
234	Ind/Commerc. Coating -Can	0	0	0	100	0	0	0	0
235	- Machinery & Equipment	0	0	0	100	0	0	0	0
236	- Wood Furniture	0	0	0	60	10	10	10	10
237	- Paper, Fabric & Film	0	0	0	100	0	0	0	0
238	- Motor Vehic. Assembly	0	0	0	100	0	0	0	0
239	- Appl & Metal Furn.	0	0	0	100	0	0	0	0
240	- Misc Metal Parts	0	0	0	100	0	0	0	0
241	- Flat Wood Stock	0	0	0	100	0	0	0	0
242	- Auto Refinishing	0	0	0	0	0	0	100	0
243	- Marine	0	0	0	50	0	0	50	0
244	- Other Coatings	0	0	0	70	0	0	30	0
250	Degreasers - Syn Solv. Mfg	0	0	0	100	0	0	0	0
251	- Petroleum Solvent Mfg	0	0	0	100	0	0	0	0
252	- Ind. Maintenance	0	0	0	100	0	0	0	0
253	- Commerc. Maintenance	0	0	0	0	0	50	50	0
265	Incineration	0	10	10	70	0	0	0	10